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STATE OF ILLINOIS
STATE GEOLOGICAL SURVEY
FRANK W. DEWOLF, Director

BULLETIN No. 31

OIL INVESTIGATIONS IN ILLINOIS IN 1914

Area south of the Colmar oil field
By William C. Morse and Fred H. Kay

The Colmar oil field—a restudy
By William C. Morse and Fred H. Kay

The Allendale oil field
By John L. Rich

Anticlinal structure in Randolph County
By Stuart Weller

Oil and gas in Gillespie and Mt. Olive quadrangles
By Wallace Lee

Work in cooperation with
U. S. Geological Survey



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LETTER OF TRANSMITTAL

STATE GEOLOGICAL SURVEY
UNIVERSITY OF ILLINOIS, April 26, 1915

Governor E. F. Dunne, Chairman, and Members of the Geological Commission.

I submit herewith a report on oil investigations during 1914 and recommend that it be published as Bulletin No. 31.

The first two papers, by W. C. Morse and Fred H. Kay, relate to the new oil fields of western Illinois which were first surveyed in 1912 and proved productive near Colmar in 1914. A restudy of the original area is presented, and also a detailed report on new territory south of the Colmar field, which was surveyed last season.

Another paper prepared for the bulletin by J. L. Rich relates to the comparatively new Allendale field in Wabash County.

The fourth paper, by Stuart Weller, describes a prominent anticlinal fold in Randolph County, which is believed to merit drilling in search of oil or gas.

The last paper by Wallace Lee of the U. S. Geological Survey, in cooperation with this office, outlines the possibilities of oil and gas accumulation in the Gillespie and Mt. Olive quadrangles of Macoupin, Montgomery, and Bond counties. The producing fields near Carlinville and Litchfield are described in detail.

Oil production in Illinois continues to be second only to that of coal. The old fields are nevertheless on the decline, and new areas must be discovered if important production is to continue. The Geological Survey is devoting much attention to the problem.

Very respectfully,

FRANK W. DEWOLF, *Director*

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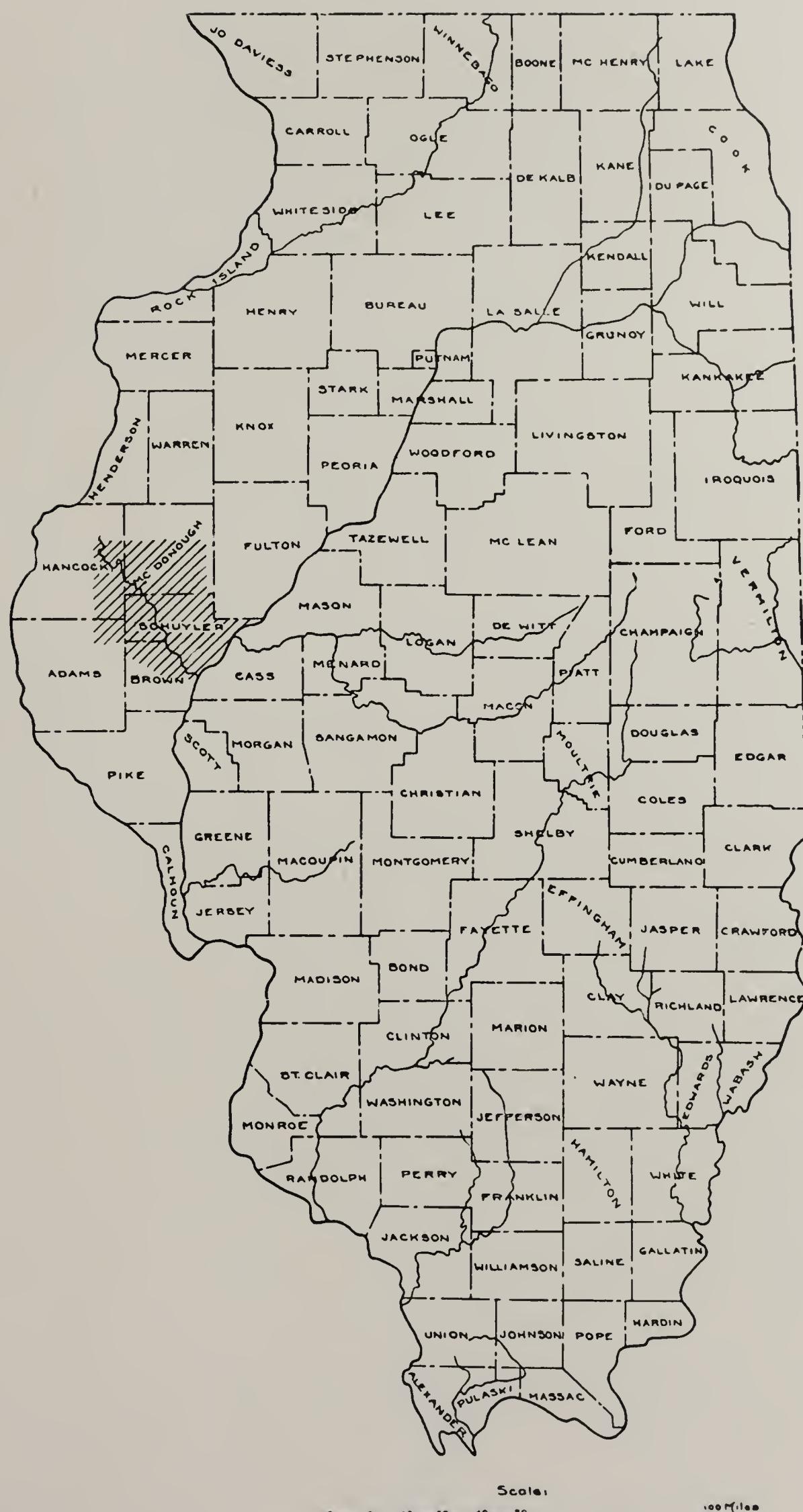


FIG. 1. Map showing area covered in first two reports.

THE AREA SOUTH OF THE COLMAR OIL FIELD

By William C. Morse and Fred H. Kay
(Field work by William C. Morse and John L. Rich)

(In cooperation with the U. S. Geological Survey)

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INTRODUCTION

Oil was discovered on the J. Hoing farm on April 30, 1914 in what is now known as the Colmar Oil Field, an area suggested as favorable for the accumulation of oil or gas in a joint report of the United States Geological Survey and the State Geological Survey by Henry Hinds¹. To date more than 130 producing wells have been completed and the output is now approximately 650 barrels per day.

In the hope of locating other areas in which the geological structure is favorable for the accumulation of oil or gas the work during the past season has been pushed on to the south. The new territory now completed (see figure 1) includes the whole of Schuyler County except the small point east of Sugar Creek; the adjoining part of Brown included roughly within lines running from Ripley to Mt. Sterling and from Mt. Sterling to Damon; and the adjacent belt on the west, one to three miles broad, in Adams and Hancock counties.

ACKNOWLEDGMENTS

An introduction to the geology of this part of the State was given by Dr. Stuart Weller, accompanied by Mr. F. M. Van Tuyl of the Iowa Survey, who met Messrs. Morse and Rich at Keokuk, Iowa, visited the type localities of the Keokuk and Warsaw formations and made with them a three-day reconnaissance automobile trip through McDonough, Schuyler, and Brown counties. Acknowledgment must also be made at the outset to Dr. John L. Rich, who was a collaborator in the study of nearly the whole of Schuyler County, and who assumed the extra duty of directing the instrument men. He would have been joint author had he not been called east before the areas in Brown, Adams, and Hancock counties and the Colmar field were studied. Free use has been made of the report of Mr. Henry Hinds of the U. S. Geological Survey, which was published under a co-operative agreement by the State Survey. Mr. Raymond S. Blatchley located and determined the elevations of about 15 producing wells and a similar number of dry ones in the Colmar field. He also secured a large number of well records which the senior author was unable to obtain because of lack of time.

A friendly cooperation was manifest on every hand, both by the owners of the farms and the oil men. Free camp sites and automobile storage, one or both, were furnished by Mr. W. C. Blackburn of Brooklyn, Mr. Roy Moore of Rushville, Mr. Hare of Mt. Sterling, and Mr. Henry Pearson

¹Hinds, Henry, Oil and gas in the Colchester and Macomb quadrangles: Ill. State Geol. Survey, Extract Bull. 23, pp. 11-13, 1914.

and son of Augusta. Well records and other information were freely given by Messrs. Page and Crew of the Ohio Oil Company, Mr. Glass of Snowden Brothers and Company, Mr. B. A. Kinney of the Lamoine Oil and Gas Company, Mr. Frank Lawler, representing Messrs. J. B. and W. H. Hazlett, Mr. P. B. Lamberton of Lamberton and Baker, Mr. Lewis of J. E. Urschel and Company, and others.

PERSONNEL OF THE PARTY

The party, in addition to Messrs. Rich and Morse, included at various times: David E. Day, John D. Mattison, J. Philip Pepper, H. S. Hsu, Victor Wood, Paul F. Morse, J. Hazlette Bell, Harold R. Moore, James A. Lee, Jas. H. Pierson, L. W. Robison, Jas. Barger, Ray Post, Harry A. Almond, and J. W. Hemphill.

METHOD OF FIELD WORK

Since the beds in the area lie approximately parallel to one another, the position and altitude of any underlying stratum such as an oil sand, can be learned by determining the position of any persistent recognizable bed exposed at the surface.

The position of the oil sand bears a direct relation to the accumulation of petroleum, as explained under "Relation of geologic structure to oil and gas accumulation;" and in the region under consideration, instrumental levels were run to outcrops of certain beds that could be somewhat easily recognized by the geologists. An attempt was made to find outcrops not more than one mile distant from one another. Field work began July 1 and continued to November 1. It was conducted from camp, and an automobile was used to great advantage. The levelman and two rodmen were taken to their work in the morning and the car was then available for the geologists in scouting for outcrops. Flags consisting of cheesecloth 18x18 inches on a lath staff, were placed upon the exposures. The location of the flag was usually determined by means of a Brunton compass and by pacing to the nearest land or road corner, and its position and number were noted on the map. A similar map or a tracing, together with detailed information concerning the flag locations, was furnished the levelman for his guidance.

KEY ROCKS

Coal No. 2 (Colchester or Murphysboro) was found to be the most useful key rock because it had been opened up at many places where all consolidated rocks were otherwise covered by glacial deposits. Furthermore, information about the coal was more readily obtained than that concerning any other bed. Since the St. Louis limestone is commonly harder than the overlying and underlying beds and was rather easily discovered, its

base was frequently used as a key horizon. In the vicinity of Rushville the Springfield (No. 5) coal, lying 120 to 130 feet above the coal No. 2, was followed; elsewhere other beds were used to a limited extent.

STRATIGRAPHY

GENERAL STATEMENT

The rocks of the area under discussion belong to two distinct types: namely, (1) unconsolidated and (2) consolidated. The unconsolidated rocks consist of material deposited by the present streams and called *alluvium*; that transported by the wind and designated as *loess*; and that deposited by the continental ice sheet and known as *drift*. The consolidated rocks are much older, were deposited earlier, and are such ordinary kinds as sandstones, limestones, and shales.

UNCONSOLIDATED ROCKS

ALLUVIUM

The alluvium is confined for the most part to the present valleys, where its thickness ranges from a few feet to 80 or more. It is for the most part clay or sand or a mixture of both of these, but at some places is coarser material. It is the first material penetrated in most of the wells which are located in the valleys.

LOESS

Over the drift in many places is a covering of fine material known as loess which is believed to have been carried and deposited more or less exclusively by the wind. As a rule it is thicker along the bluffs overlooking the larger valleys, and thinner farther back from the streams. Because of this localized distribution and peculiar composition, which in some cases, at least, is very similar to finely ground glacial material or rock flour, the loess is believed to have been swept out from the glaciers by streams, spread out over the flood plains, and then after the floods subsided and the material became thoroughly dry, picked up and deposited over the neighboring uplands by the wind. In texture it is intermediate between clay and sand. Although unconsolidated, when undercut it is capable of standing in vertical or slightly overhanging cliffs (see figure 2). Another characteristic is its division by joint planes into vertical columns. The thickness of the loess, like that of the drift, varies from place to place; but in the area under discussion it is especially thick along the western bluffs of Illinois River (see figure 3).



FIG. 2. Loess in the west bluff of Illinois River below Frederick.



FIG. 3. Loess hills above the outwash plain, looking toward Illinois River near Frederick.

DRIFT

The drift belongs to one of the earlier periods of glaciation, the Illinoian. Nearly everywhere in this area it conceals the bed rock and adds much to the labor of the geologist in determining the position of the bedded rocks. The drift contains fragments of many kinds of rock (limestone, sandstone, granite, gneiss, schist, and others) over which the glacier or ice sheet passed.

In places the constituents are assorted into clay, sand, gravel, and bowlders; and in others they may be mixed together in a heterogeneous mass. In this area the drift is for the most part fine material containing few large bowlders. At most places outside of the valleys the drift is the first material penetrated by the drill and in places the presence of bowlders in the soft material deflects the drill so as to produce a crooked hole which has to be abandoned.

CONSOLIDATED ROCKS

GENERAL DESCRIPTION

The consolidated rocks of interest to the oil operator in this region include the formations from the lower part of the "Coal Measures" down to the St. Peter sandstone which underlies the Trenton limestone.

At different places in the area all of the formations down to, and including, the Keokuk limestone are exposed and may be studied in detail. Below the Keokuk the beds are known from samples obtained by drilling.

The inserted generalized section serves as a key to identify the formations on the outcrop or in drillers' records.

The following is a composite section from measurements of various outcrops in the region.

Composite section of exposed rocks

Pennsylvanian series

Carbondale formation

	Ft.	In.
A. Limestone, nodular, bluish black.....	..	6
B. Shale, hard, black, carbonaceous, slate-like, with nodules or concretions of hard, dark limestone. Large <i>Lingulæ</i> and <i>Orbiculoidæ</i>	2	6
C. Coal, Springfield (No. 5), broken by clay seams and slightly faulted. Mined. The Mt. Sterling 18-inch bed is probably the same.....	5	..
D. Commonly covered, the exposed portions consisting of shales and underclay	7	..
E. Limestone, nodular or brecciated. Exposed at Mt. Sterling, but not noted so fully developed at other places.....	3	..
F. The first interval of twenty or thirty feet beneath the Springfield (No. 5) coal is commonly covered. Sandy shales and shaly sandstones, the layers of which in places thicken up and form more massive sandstones. In places cementation has been more pronounced, resulting in harder and more resistant layers. In still other places more thorough cementation has developed large flat con- cretions, which are more conspicuous where weathering has removed the adjacent parts of the layers. Massive sandstone in places, shales in others. The uneven erosion		

	Ft.	In.
surface at the base probably represents an unconformity. More or less of the whole interval of 100 feet from the Springfield (No. 5) coal to the limestone below is subject to variation in constitution.....	90	..
G. Limestone, dark gray. Ranges from 6 inches to 7 feet in thickness and is nodular in places. Contains <i>Chonetes mesolobus</i> , <i>Productus</i> , Crinoids, and other fossils.....	4	..
H. Shale, hard, black, carbonaceous, and slate-like, which may be somewhat softer at the base. It contains flat and spherical concretions of dark limestone; <i>Orbiculoidæ</i> and <i>Lingulæ</i> are common.....	4	..
I. Shales, soft blue clay; at some places 16 or 18 feet thick and at others only 2 or 3 feet, or wanting. This irregularity in thickness is due to irregular deposition. The bed of black shales above is wavy as a result of this variation	12	..
J. Coal, Colchester (No. 2), mined. This coal with the overlying black shale and limestone is the most constant horizon in the Pennsylvanian in this part of the State....	2	6
Pottsville formation		
K. Underclay and shaly clay.....	2	6
L. Shales, soft clay, 1 to 10 feet in thickness.....	6	..
M. Limestone, nodular, conglomeratic, or brecciated.....	3	..
N. Clay or shale or shaly clay which becomes more sandy toward the bottom and passes into sandstones. This is the Cheltenham clay horizon, the clay being especially well developed and valuable at some places.....	14	..
O. Coal which ranges from 6 inches to 18 inches in thickness and which may consist of two beds. It is commonly called No. 1.....	1	..
P. Shales, blue, clayey, and sandy, grading into sandstones....	15	..
Q. Sandstone, irregular with some sandy shale.....	5	..
Marked unconformity		
Mississippian series		
St. Louis limestone		
R. Limestone, hard, bluish gray. Portions of the limestone are in regular layers, and other portions are decidedly irregular. In places the limestone is brecciated, the angular pieces being almost exclusively limestone, and in others the limestone is decidedly sandy. In the lower part of the formation lenses of sandstone are present which seem to be formed of sand which was washed into cavities	20	..
Salem and Warsaw formations		
Thin- to thick-bedded sandy limestone or dolomite. Resembles very fine-grained, limy sandstone. Generally has yellow to brownish-yellow tint. Toward base is compact, bluish limestone. Dull sound when struck with hammer; this characteristic is helpful in distinguishing Salem from St. Louis which rings when struck.....	18	..

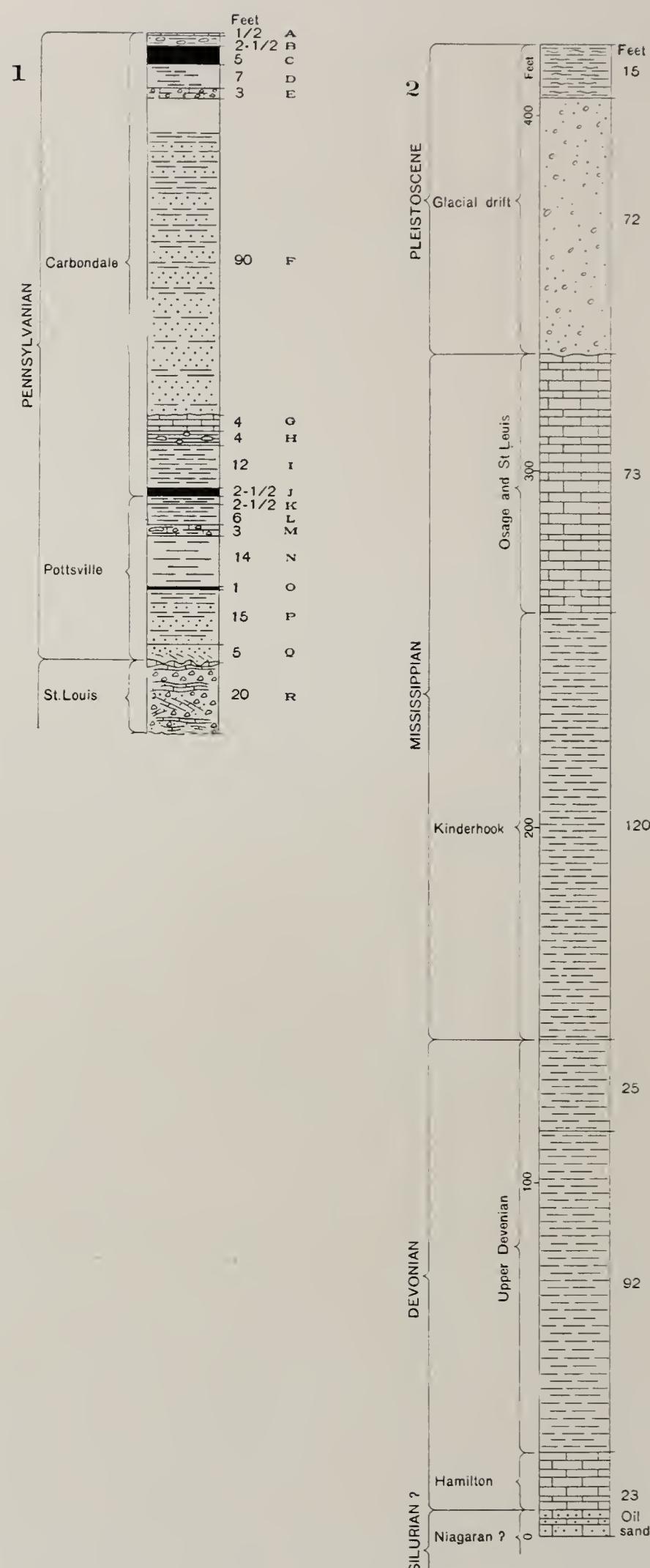


FIG. 4. Graphic sections:

1. From measurements on outcrops (see "Composite" section, page 14).
2. Log of Hoing No. 1 well.

	<i>Ft.</i>	<i>In.</i>
Limestone, shaly, and blue, shales, some of which are filled with fragments of bryozoans and small shells. Small geodes are present in places.....	24	..
Base not exposed. Underlying Keokuk limestone exposed in region but no continuous section from Salem downward could be found.		

Figure 4, section I is a graphic representation of the section given above, including the beds to the base of the St. Louis limestone. By taking No. I in connection with the graphic log of the Hoing well on the left, (No. 2), the reader may gain a definite idea of the beds to be penetrated in drilling to the oil "sand".

CARBONDALE FORMATION

The Carbondale formation includes all of the beds from the top of coal No. 6 down to the base of coal No. 2. The former coal is not present in the area under consideration.

Exposures at few places show beds higher than a few feet above coal No. 5, which lies 50 to 100 feet below coal No. 6 in other parts of the State.



FIG. 5. Colchester (No. 2) coal and overlying black, concretionary shales west of Rushville.

In the vicinity of the Colmar oil field most of the coal-bearing rocks were eroded before glacial times, and in many places the first rocks under the drift are Mississippian limestones. Toward the south and east, the

Carbondale is present in greater thickness. Near Pleasant View 130 feet of this formation was measured.

The Carbondale consists largely of shales and sandstones, but it also contains thin beds of limestone, underclay, and coal. Coal No. 2 (Colchester) is one of the most persistent beds of the Pennsylvanian series in Illinois. In spite of its thickness of only 24 to 30 inches, it has been opened up at many places along the outcrop. Directly above coal No. 2 or separated from it by a few feet of soft, clay shales, is a bed of hard, black, carbonaceous, slate-like shale similar in appearance to that above the Springfield (No. 5) coal (see figure 5). It contains nodules of hard, dark limestone and fossil *Orbiculoidæ* and *Lingulæ* which are smaller than those in the shales associated with coal No. 5. Above the black shales is a stratum of fossiliferous limestone, here and there chert-like. In this phase the fossils appear white against the dark background.

Coal No. 5, which is confined to a small area north of Rushville and Pleasant View is commonly 5 to 6 feet thick and contains clay seams that cut across the bedding planes of the coal. The beds above coal No. 5 are very similar to those above coal No. 2. The roof is a hard, black shale overlain by a nodular limestone containing fossils. In the shale are nodules and fossil shells of *Orbiculoidæ* and *Lingulæ* which are larger than those in the shale above coal No. 2. Below the floor clay of coal No. 5 is a nodular limestone not unlike that beneath the Colchester coal.

POTTSVILLE FORMATION

The Pottsville formation includes all beds from the base of coal No. 2 to the base of the Pennsylvanian series. Like the Carbondale formation it too is made up for the most part in this region of shales and sandstones, but contains minor amounts of limestone, underclay, and coal. A few feet

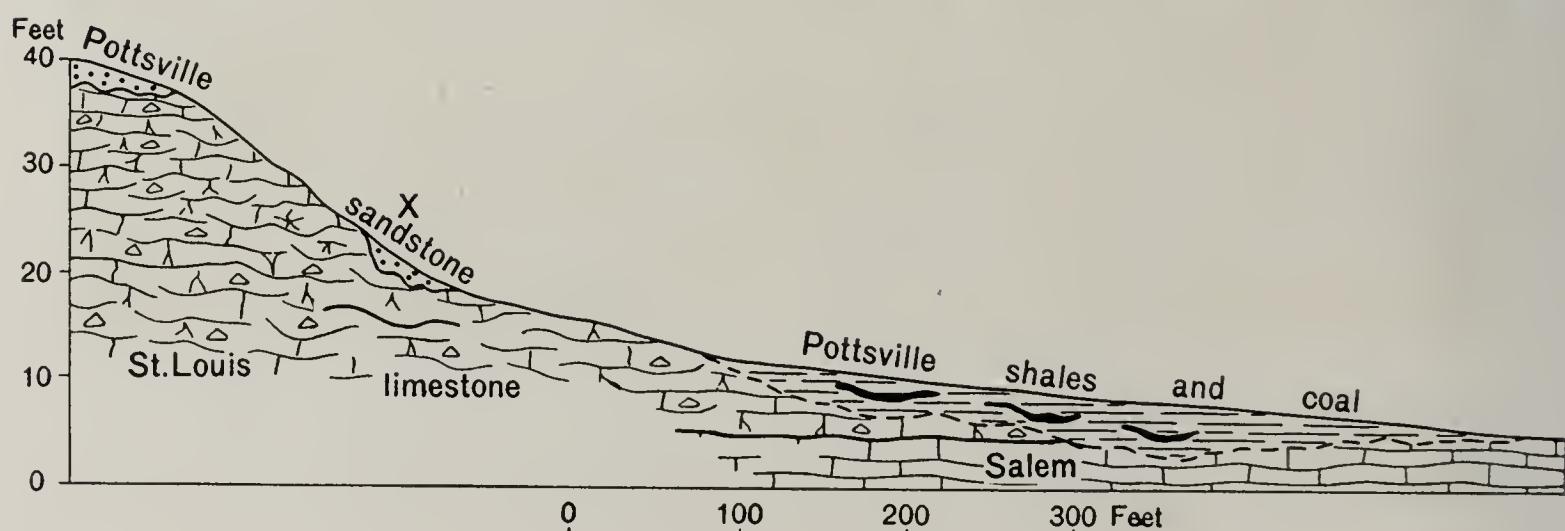


FIG. 6. Unconformity at base of Pottsville, Harrison Branch, north of Huntsville.
The diagram above point marked "X" represents hillside outcrops, that below "X" represents longitudinal section of stream bed.

beneath coal No. 2 is a bed of limestone which is either nodular or brecciated and is not unlike the St. Louis, but can be readily distinguished from it where fossils are present. A thin coal is found beneath coal No. 2 at many

places, but owing probably to its lenticular nature no single bed persists over a large area.

The "Coal Measures" rocks were deposited on a former land surface with hills and valleys; consequently the thickness is extremely variable. The Pottsville formation lies at some places on the St. Louis limestone, at others on the Salem formation, and elsewhere on still older formations. Such a relationship is called an *unconformity* since the normal sequence of deposition has been interrupted by a period of erosion. Figure 6 is a sketch showing the unconformity at the base of the Pottsville in Harrison Branch, north of Huntsville.

ST. LOUIS LIMESTONE

In most places the St. Louis is a brecciated, poorly bedded limestone. Well-defined layers are exceptional. Most of the angular fragments are limestone and vary in size from grains to blocks 2 feet or more in diameter (see figure 7). The color is blue at most places, although here and there a



FIG 7. Brecciated and conglomeratic St. Louis limestone east of Birmingham.

yellowish tint is noticeable. The limestone is barren of fossils, except large hemispheres of the coral *Lithostrotion canadense*, which are harder than the surrounding stone and must have collected as residual material on the old St. Louis surface as the limestone weathered away, since most of them are now in the base of the Pottsville sandstone.

When the St. Louis was land surface, caverns were formed in the limestone as the result of solution by acid waters, just as caves now form

in limestones. Later the Pottsville was deposited on the St. Louis, and some of the sand settled down into the old caves as shown in figure 8.

The St. Louis commonly has a thickness of 18 to 20 feet but in places



FIG. 8. Caves in St. Louis limestone filled by Pottsville sands. (Photo by Rich)



FIG. 9. Erosion planes in the St. Louis limestone in Harrison Branch north of Huntsville.

it reaches more than 30 feet. In many parts of the region it has been completely removed by pre-Pottsville erosion.

The surface on which the St. Louis was deposited was not rough; the greatest departure from a level noted is $8\frac{1}{2}$ feet in a horizontal distance of 100 feet in Williams Creek about 3 miles northwest of Huntsville. Besides the unconformities at the top and bottom, the St. Louis contains erosion planes as shown in figure 9.

SALEM FORMATION

Below the St. Louis, and in unconformable contact with it, is a variable thickness of yellowish, magnesian limestones, limy shales, and limy sandstones correlated with the Salem formation. In many places difficulty is experienced in correctly classifying the material as limy sandstone or as impure limestone. *Geodes are abundant*, but fossils are scarce. When struck with a hammer the Salem gives a dull sound, in decided contrast to the ringing sound of the St. Louis limestone.

Thirty feet or more of the Salem was measured in the region, but because of the unconformities at top and bottom, and also because of the similarity between the basal beds of the Salem and the top strata of the Warsaw, the thickness of the former is uncertain.

The following section is typical of the Salem in this region.

*Measured section of Salem formation along stream and road between
secs. 5 and 6, T. 2 N., R. 3 W.*

	Ft.	In.
5. Limy shales, impure, yellowish, and bluish, and impure yellowish limestones with chert and quartz geodes at a number of horizons. The layers are more massive at the base.....	20	..
4. Not exposed, probably shale.....	12	6
3. Shales, blue	4	..
2. Limestone, impure and yellowish, with bryozoa and <i>Productus</i>	4	..
1. Clay shale, blue; and sandstone.....	3	6

WARSAW FORMATION

The Warsaw formation in this region is composed of 30 to 40 feet of interbedded blue clay shales, and thin, impure limestones. The shales contain abundant bryozoans, and in the limestones a large spiral fossil of this class known as *Archimedes* is very characteristic.

The following sections show the variable nature of the Warsaw in this region. They probably include some of the overlying Salem since it is impossible to determine the contact between the two.

*Section of part of Warsaw formation in the south central part of
sec. 14, T. 3 N., R. 4 W.*

(Section may contain few feet of Salem formation)

	Ft.	In.
3. Clay shales, hard, blue; and sandstones with very little lime, yellow, and like Salem at base.....	8	..

	Ft.	In.
2. Limestone, crystalline, massive, grading up into sandy limestone, yellow; large <i>Archimedes</i>	10	..
1. Clay shales, soft, blue, and fossiliferous.....	2	6
<i>Section of part of Warsaw formation in the NE. cor. sec. 26, T. 3 N., R. 4 W.</i>		
	Ft.	In.
2. Limestone, thick, reddish brown, crystalline, with sandstones between. The upper limestone contains a large roseate brachiopod and the lower one contains <i>Archimedes</i> , corals, and brachiopods.....	12	..
1. Clay shales, soft, blue, filled with bryozoans, brachiopods, pelecypods, and <i>Archimedes</i>	5	..

KEOKUK LIMESTONE

The Keokuk limestone is the lowest formation exposed in the region. It consists of 30 feet or more of gray, crystalline, very fossiliferous limestone, which grades upward into the Warsaw shales. The main body of the Keokuk is evenly bedded as shown in figure 10.

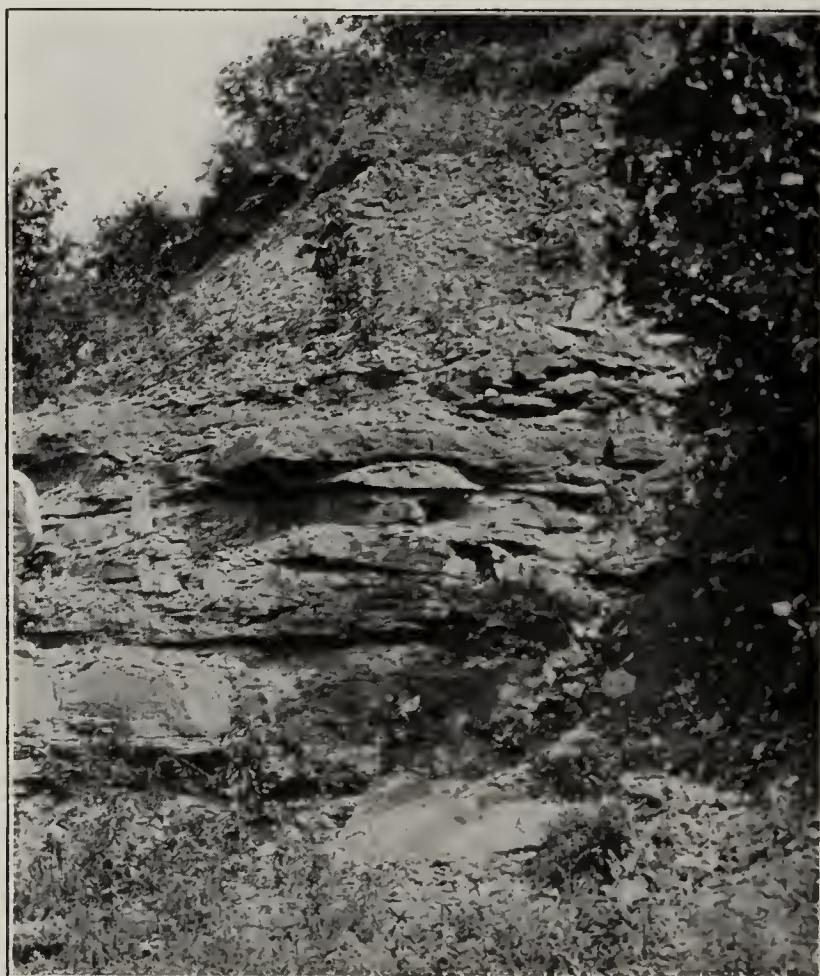


FIG. 10. Keokuk limestone near Plymouth. (Photo by Rich)

BURLINGTON LIMESTONE

The Burlington limestone does not outcrop in the region, but it is believed to be represented by certain cherty limestones penetrated by the drill while passing through the base of the Mississippian or so-called "first lime". In the Littleton well, recently drilled, the lower part of the limestone from 270 to 445 probably represents the Burlington.

KINDERHOOK AND UPPER DEVONIAN SHALE

The "first" and "second" limes are separated by about 200 feet of shale. The upper 100 feet, usually a bluish-gray, sandy shale, represents the Kinderhook. Samples from the Littleton well show 100 feet of Kinderhook shale underlain by 100 feet of dark gray to olive shale containing *Sporangites* which prove it to be of Upper Devonian age. The lower part contains shales of somewhat lighter color.

DEVONIAN LIMESTONES

A thin, non-magnesian limestone usually reported as gray, and in some places said to contain pyrite, underlies the shale mentioned above. In most of the wells thus far drilled this limestone is not more than 15 feet thick, although it is difficult to distinguish from the underlying limestone. It forms the upper part of the drillers' "second lime."

NIAGARAN FORMATION

Below the limestone described above is a gray to pink crystalline dolomite which probably represents the Niagaran. Where it is present, it forms the lower part of the "second lime" and would probably not be distinguished from the Hamilton limestone above.

Since the Niagaran was deposited on an eroded surface of Maquoketa shale and was itself exposed to erosion before the overlying Hamilton was deposited upon it, the thickness of the Niagaran is extremely irregular. In some places it was completely eroded. The combined thickness of the Hamilton and Niagaran is rarely more than 50 feet.

In the western part of Illinois, the Niagaran is closely associated with oil production. It contains the gas in Pike County, where the dolomite is also oil soaked in places. On the outcrop in Calhoun County near Bettontown, the Niagaran is a fine-grained, buff-colored dolomite that falls to powder under the hammer, and is so porous that it could easily act as a reservoir for oil and gas. The "broken" sand so often reported at the base of the "second lime" is probably the porous basal part of the Niagaran. The oil sand probably represents reworked material at the base of the Niagaran and is properly classed as part of that formation.

ORDOVICIAN FORMATIONS

Below the Niagaran the drill penetrates a variable thickness of shale, generally bluish or greenish and usually easily distinguished. In the Griggsby well in the W. 1/2 SE. 1/4 sec. 20, T. 4 N., R. 4 W. the Maquoketa or Richmond shale as it is called, is 187 feet thick and in other wells that penetrate the formation, it generally ranges from 180 to 200 feet. Recent

drilling seems to indicate that 6 or 8 miles north of the Colmar field, the Maquoketa may be much thinner than indicated above; probably on account of erosion before the Hamilton was deposited. In the latter area the Maquoketa also contains shaly textured dolomites in contrast to the typical shales further south.

Below the Maquoketa is the Kimmwick-Plattin (Trenton) limestone which in the region covered by this report is non-magnesian, gray, and somewhat crystalline. Thus far it has not been found to contain oil in the western part of Illinois. South of this region, in Calhoun County, the Trenton outcrops and is seen to be composed largely of shells. When struck with the hammer, the odor of oil is very prominent.

About $1\frac{1}{2}$ miles north of Beechville, Calhoun County, the Trenton contains a conspicuous amount of bituminous matter. The rock must have been highly organic originally, and it is not unlikely that some oil originated in this formation. Drillers in Illinois often report the odor of petroleum from the Trenton. It was penetrated 200 feet in Griggsby No. 1 and it may be 300 to 400 feet thick. Because of its compact nature, it does not tend to be as favorable for accumulation as does the more porous Niagaran, but it should be tested in wells where the structure is favorable in order to explore all possible oil horizons.

POSITION OF THE HOING OIL SAND IN THE SECTION

The producing stratum lies beneath the "second lime" and at the base of the Niagaran formation. Samples from producing wells show that it is a round-grained quartzitic sand of variable thickness.

The sand exists in lenses and appears to be material that was washed into the valleys and low areas when the Maquoketa shale was land surface and exposed to erosion. It was reworked, of course, by the Niagaran sea. Its areal distribution is spotty and in many places the drill passes from the "second lime" directly into the Maquoketa shales, with no intervening sands.

It is possible that the lower part of the Niagaran dolomite is in some places responsible for a show of oil but it is believed that important accumulation is dependent on the presence of the more porous sand. It is obvious that the presence of the latter cannot be predicted in advance of the drill.

STRUCTURE

GENERAL STATEMENT

The significance of the unconformities described under "Stratigraphy" is shown graphically in figure 11, the unconformities being represented by the irregular contact lines between different formations. Such contact planes are simply ancient land surfaces, some of which had almost as

much relief as the surface today; whereas others exhibit a relief of only a few feet.

In selecting a key rock the elevation of which is to be determined throughout a region, in order to learn the position of underlying oil sands, it is necessary to know that the bed is approximately parallel to the deeper beds or that the departure from parallelism is regular and determinable. An unconformable contact between two formations is worthless for this purpose in Illinois if the irregularities in the old surface as shown by the plane of contact exceed 15 feet. For example, the contact between the "Coal Measures" and the Mississippian limestones or "first lime," as shown in figure 11, would be valueless in determining the position of the Hoing

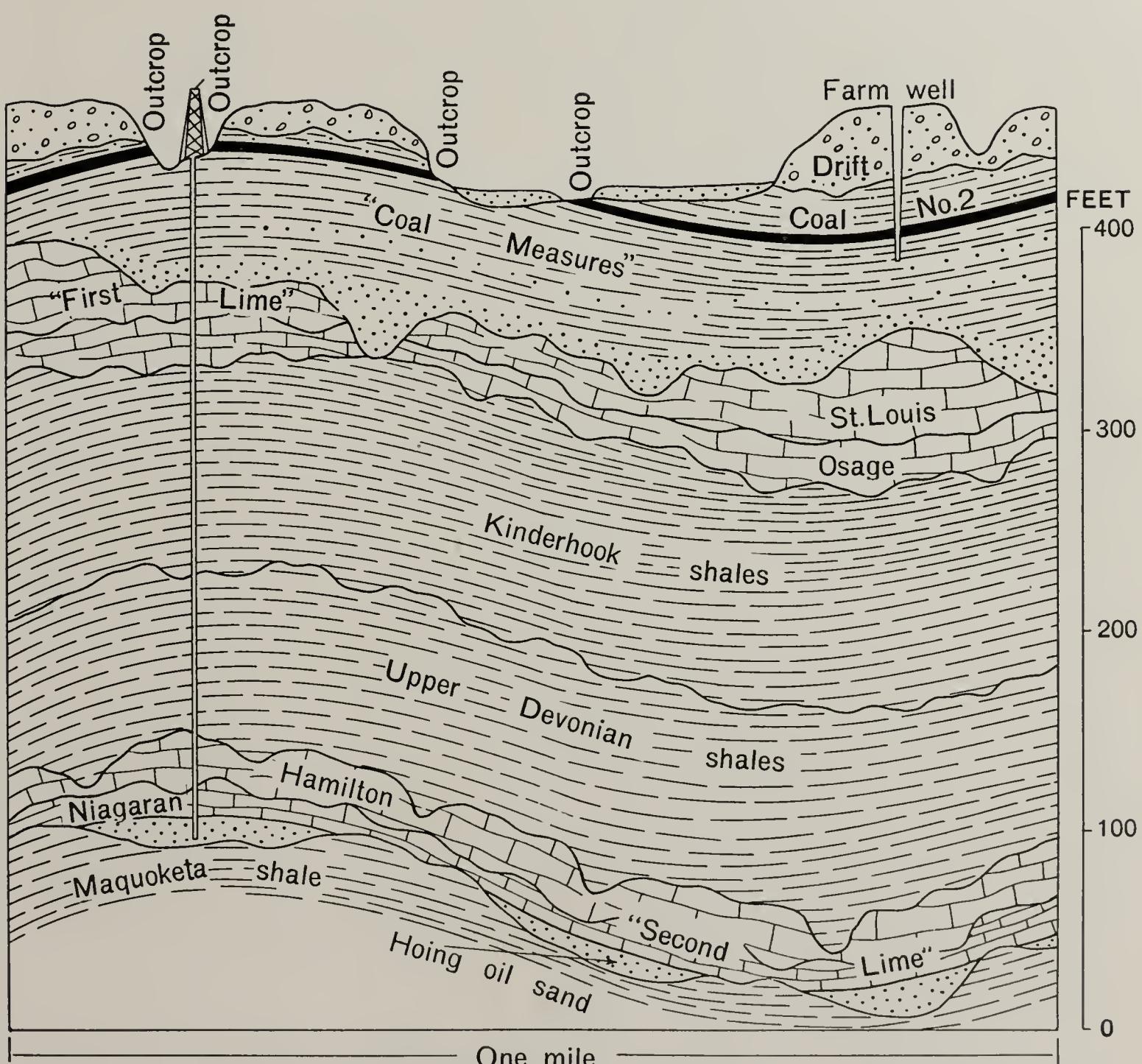


FIG. 11. Diagram showing significance of unconformities in the Colmar region.

sand, since levels on this contact would merely determine the height of the hills on the old land surface rather than any folding which the beds had undergone. On the other hand, the base of the St. Louis limestone, although

in unconformable contact with lower formations, serves as a safe horizon because the irregularities in the plane of contact are slight.

So far as is known, regardless of the many oscillations of the region above and below sea level and despite the long periods of time represented by the formations and their unconformities, there was practically no warping or folding of the beds from the time the Hoing sand was deposited until after the "Coal Measures" were laid down. Such folding as then took place affected all the beds alike. Were it not for this fact, geological work on beds at the surface would be almost useless in determining underlying structures. During the submergence which followed the exposure of the St. Louis limestone as a land surface, it is possible that the sinking was slightly greater toward the northwest since we now find in that direction an increasing interval between the base of the St. Louis and coal No. 2 lying above. The interval varies from about 45 feet in southeast Schuyler County to about 75 feet in the vicinity of Colchester.

RELATION OF FOLDS IN AN OIL-BEARING STRATUM TO ACCUMULATION

In most of the oil fields of the State, the accumulation is intimately connected with the upward folds in the strata. It is the usual experience to find the oil near the crests of the anticlines or where terraces exist on the sides of the anticlines. Both types are illustrated in the main oil fields of Lawrence and Crawford counties.

The fact that every known field in Illinois is surrounded by wells which tap only salt water, is strong evidence that the latter is a most important factor in determining where the oil will accumulate in a sand that has been folded in undulations. If the sand is practically saturated with salt water, the result is generally a forcing of the oil into the crest of the fold as shown in figure 12, A. In case of partial saturation, the oil is found farther down the sides of the folds and the crest may be dry or it may contain some gas (fig. 12, B). If the sand is dry, the oil is permitted to collect in the basins or synclines, and the anticlines prove unproductive (fig. 12, C).

The productive part of the sands in the southeastern Illinois fields is near the crest of the well-defined La Salle anticline or on terraces which are part of this same fold. On the sides of the anticline, salt water fills the producing sands almost to the crest.

In the western part of Illinois, however, many of the conditions are different from those in the fields just mentioned, and it would not be surprising if oil is found in positions entirely different from those better known heretofore.

In attempting to locate possible undiscovered fields in western Illinois the following facts must be given due consideration:

1. The structural features—that is, folds—are small in area and in magnitude. The crests of many of the domes and anticlines are not more than 20 or 30 feet high.

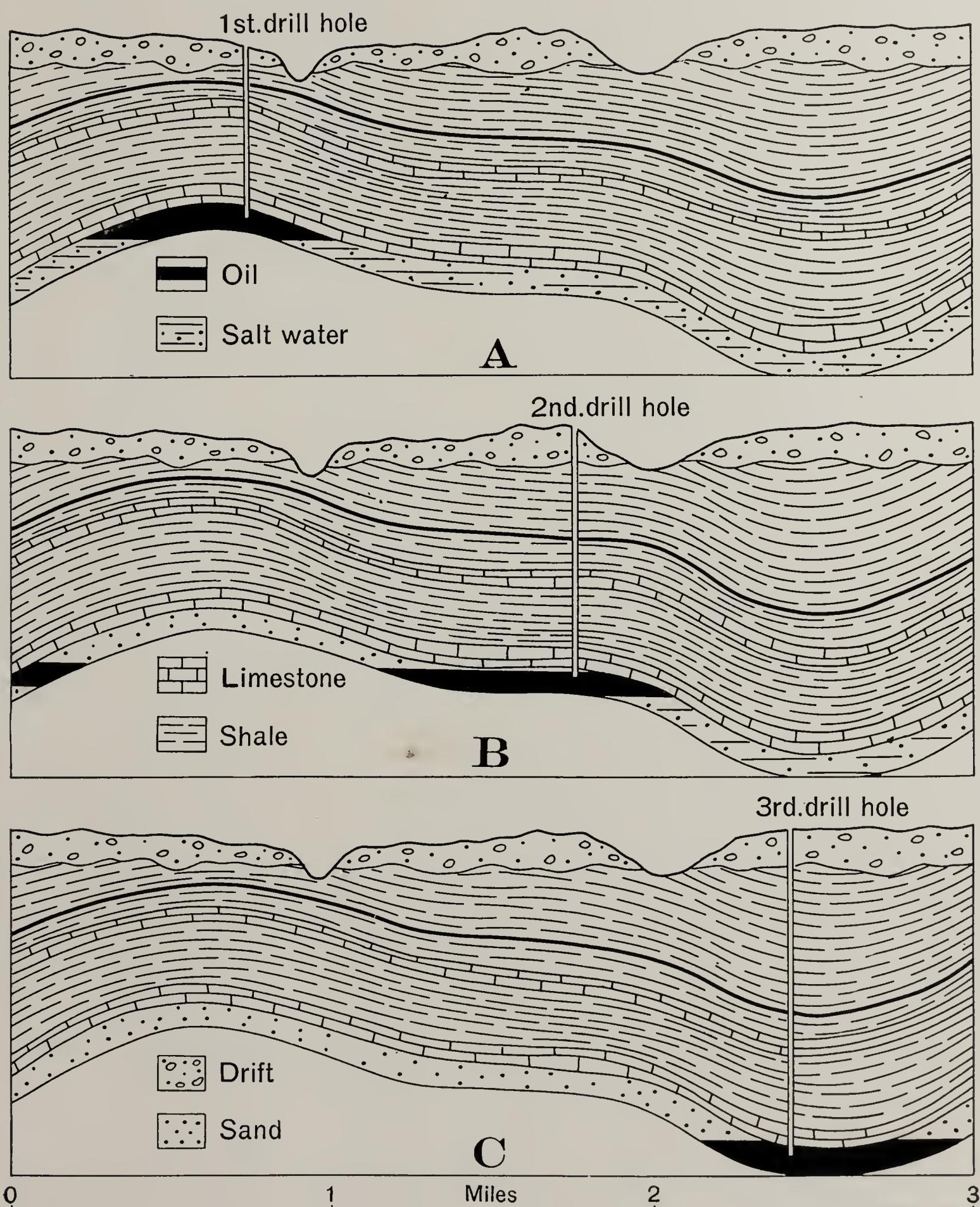


FIG. 12. Diagram showing conditions governing oil accumulations:

- A. In oil sands saturated with salt water.
- B. In oil sands partly saturated.
- C. In sand containing no salt water.

2. The oil-bearing horizon is extremely variable in thickness and in character.

3. Drilling already done shows that oil and salt water exist in separated areas and at so widely different elevations that no lateral connection between the deposits of one area with another is conceivable.

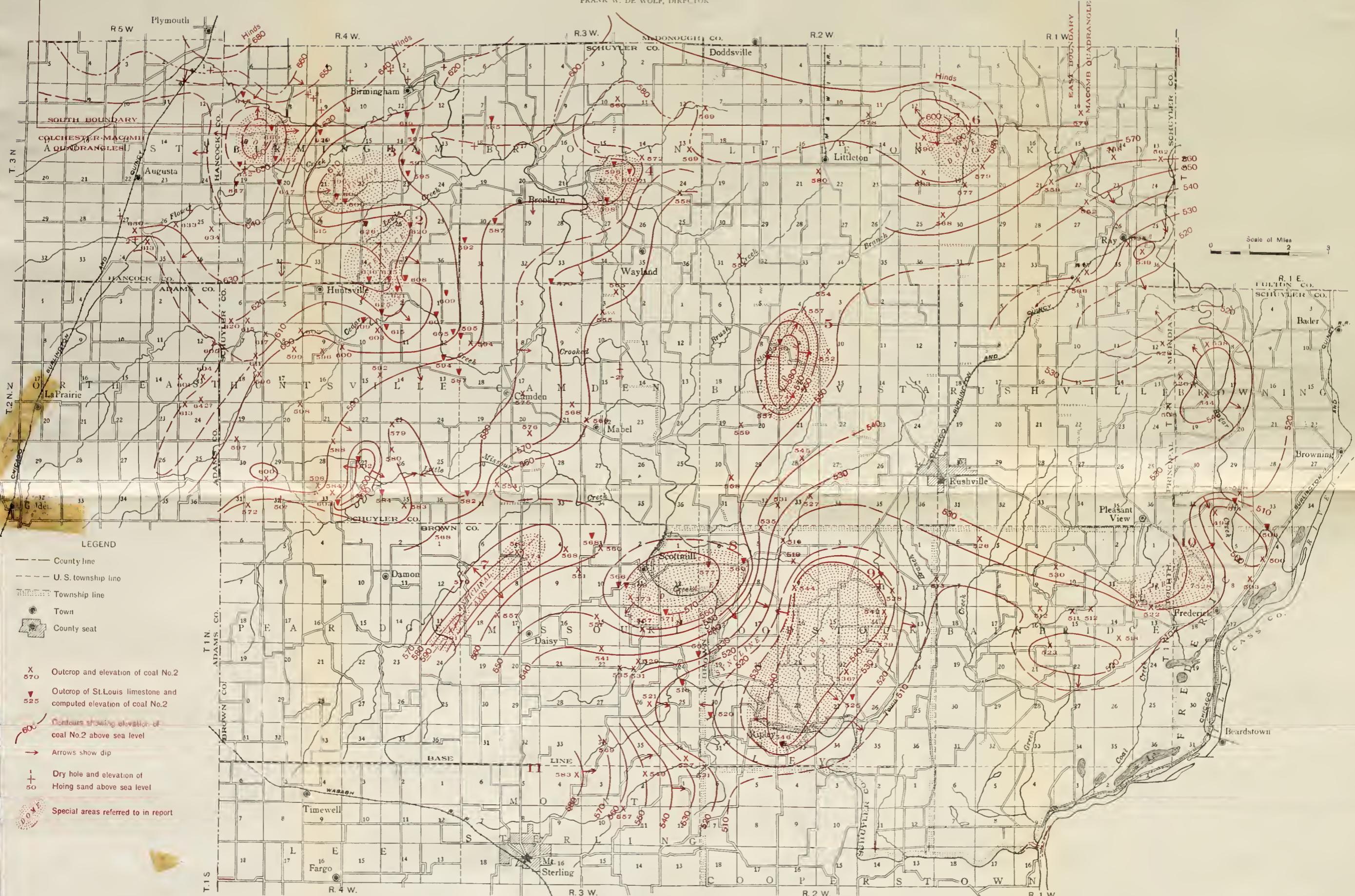
1. In the eastern part of Illinois the beds at the crest of the La Salle anticline lie 500 feet higher than in the basins bordering the fold. The anticline is of sufficient magnitude to be easily identified and traced, and its influence on petroleum accumulation is clearly defined. In the western part of the State, however, the beds dip gently eastward, and the folds that have developed are merely small irregularities in, or interruptions to, the general dip. The altitude of the sand has been determined from outcrops of beds at the surface, the parallelism of the strata being assumed. In the Colmar field, the sand is parallel to the beds lying above and shows the same folding as the coal. However, the drilling of domes and anticlines where the crests rise only 20 or 30 feet, is recommended with considerable hesitancy.
2. The sand that contains the oil was probably deposited only in the valleys and basins in the Maquoketa shale. Consequently the bed is not continuous, but exists as lenses of various shapes and sizes, entirely separated from one another. This assumption is confirmed by the records from some of the wells in which little or no sand was found at the Hoing sand horizon.
3. The location of the salt water in the territory thus far studied presents a serious problem. In the Colmar field the salt water is found in the lower part of the sand on the terrace and also lower down the dip. At the east end of the crest of the elongate dome, the Collins and Griggsby wells showed a small amount of oil and no salt water; whereas at the west end of the dome the Roberts No. 1 well, which taps the sand at the same elevation as the wells named above, produces oil in commercial quantities and is surrounded by wells lower down the dome which produce only salt water, existing high in the dome, almost 50 feet above the level of the oil in the Colmar field only three miles distant. In the vicinity of Birmingham, and between this place and Augusta, a number of wells have been drilled, and although the Hoing sand was found in most of them and notwithstanding the fact that the highest of these wells structurally, taps the sand at least 60 feet below the salt water near the Roberts No. 1 well, careful investigation discloses the absence of salt water in the lower wells. In fact, below about 100 feet where fresh water required casing, it was necessary to add water to most of these wells for drilling purposes.

It is clear then that regardless of position above sea level, certain areas may be saturated with salt water and possibly with accompany-

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BULLETIN NO. 31, PLATE I



MAP OF PARTS OF SCHUYLER, BROWN, ADAMS AND HANCOCK COUNTIES
SHOWING POSITION OF UNDERLYING BEDS BY MEANS OF CONTOURS ON COAL NO. 2.

By William C. Morse and John L. Rich, 1915.

ing trapped oil, whereas between these areas there may be no oil nor salt water.

The explanation of the features mentioned is probably to be found in the fact that the sand now exists in separated lenses surrounded at the sides as well as at the top and bottom by impervious beds, and accumulation is free to progress in each lens independently as outlined under the topic "Conditions governing accumulation in the Colmar field," to which the reader is referred.

Under these conditions the degree of saturation by oil and salt water will govern whether accumulation will take place at the top of the folds, in terraces lower down, or in the synclines.

Taking all features into consideration, the Survey recommends that the first test holes be located near the crests of the domes and anticlines pointed out under the topic "Recommendations." In doing so the operator will be prospecting the areas that are normally the most favorable. If the crests are found to be barren of oil and to contain no salt water, other wells should be drilled in positions to test the sand at lower elevations, preferably terraces as shown on the structure map. In locating wells on a flat portion of the sand (terrace) it should be remembered that the accumulation is likely to be at the downward-dipping edge of the terrace as shown in figure 12, B. Should the terraces prove barren of oil and salt water, it is recommended that at least a few of the synclines be drilled, the supposition being that in the absence of salt water in the higher structures the oil would be in the troughs.

DETAILED STRUCTURE

GENERAL STATEMENT

Elevations upon either or both coal No. 2 and the basal contact of the St. Louis limestone were secured wherever possible at intervals of one mile or less. These elevations were recorded upon a study map which revealed the following general structure of the two beds.

In general coal No. 2 dips to the south of east—from the highest elevation of 630 feet, in secs. 25 and 26, T. 3 N., R. 5 W. (Augusta), Hancock County, to the lowest elevation of about 500 feet along Illinois River in the vicinity of Browning and Frederick, Schuyler County. Upon this larger structure in places there are some minor features which take the forms of small domes, anticlines, terraces, and synclines. The general dip, however, persists over large areas, and the coal bed lies nearly flat in a belt 4 to 6 miles wide stretching from Littleton to a point beyond Mabel (see Plate I) and probably in a similar belt stretching southeast from Littleton through Rushville to Pleasant View, although elevations in this latter belt are very meagre because of the lack of coal outcrops.

Like coal No. 2, the St. Louis limestone in the region under discussion, has a general dip to the south of east. It dips from the highest elevation of 580 or 590 feet in the vicinity of Huntsville and the northwest part of Schuyler County to the lowest elevation of about 450 feet along Illinois River between Browning and Frederick. Furthermore, the total amount of dip of these two horizons is about the same, being 130 feet for coal No. 2 and 140 feet for the St. Louis limestone. Upon this general structure of the St. Louis limestone there are also minor structural features similar to those shown by coal No. 2.

Because of the general parallelism between coal No. 2 and the St. Louis limestone, and especially because in areas where exposures of the one are absent, outcrops of the other are commonly present, it has been regarded advantageous to combine the data regarding the two beds in a single map on which the altitude of the beds has been shown by means of contour lines. Where coal No. 2 is present the contours represent elevations run to that bed; where it has been eroded, its former elevation was determined by running elevations to the base of the St. Louis limestone and adding to this figure the average thickness of beds between the base of the St. Louis and coal No. 2. This thickness is 40 feet at the southeast part of the area and increases regularly toward the northwest as explained on page 26. At the northwest corner of Schuyler County the interval is 75 feet, as determined by Mr. Hinds in his work in the Colchester and Macomb quadrangles.

FOLDS SHOWN BY COAL NO. 2 AND ST. LOUIS LIMESTONE

A minor dome has been formed in the coal to the east of Littleton, its apex being in secs. 12 and 13, T. 3 N., R. 2 W. (Littleton). The bed in the immediate vicinity rises from about 550 feet on the southeast and from a little less than 580 feet on the north to its maximum elevation of about 600 feet. Both the St. Louis limestone and coal No. 2 between secs. 8 and 21, T. 2 N., R. 2 W. (Buena Vista), lie at elevations 10 to 20 feet higher than they do in the immediate vicinity to the north, east, and south, as indicated on the map (Plate I). It must be noted, however, that the rise of the beds is a *very* slight one.

Coal No. 2 in secs. 14 and 9, T. 1 N., R. 2 W. (Woodstock), and the St. Louis limestone in sec. 33, T. 1 N., R. 2 W. (at Ripley), reach elevations 20 to 30 feet higher than they do in the adjoining territory. Between these points elevations of the beds are not available for the reason that they are not exposed at the surface. The area of elevated strata is probably about as that represented on the map (Pl. I) within the limits of the 540-foot contour line. It is also a *minor* feature with unknown limits.

In sec. 7, T. 1 N., R. 2 W. (Woodstock), and in secs. 10, 11, and 13, T. 1 N., R. 3 W. (Missouri)—that is, at Scott Mill—the St. Louis lime-

stone reaches an elevation 50 or 60 feet higher than it does to the south. Although elevations are not obtainable to the north, the limits of the elevated beds are probably correctly shown by the 570-foot contour line. Coal No. 2 lies at a higher elevation along what seems to be a small anticline whose axis runs southwest from sec. 5, T. 1 N., R. 3 W. (Missouri), through sec. 13, T. 1 N., R. 4 W. (Pea Ridge); but here also the rise is only a few feet. The coal bed also rises rather rapidly westward from 520 feet to 580 feet in sec. 4, T. 1 S., R. 3 W. (Mt. Sterling); but unfortunately lack of exposures and of field study makes it impossible to state now whether this bed continues to rise in this direction or culminates here in its highest observed point.

In the area under discussion the greatest elevation which coal No. 2 attains is near the county line slightly north of west of Huntsville where the bed is more than 630 feet above sea level. The exact nature of this structure is not clear, because the bed is concealed to the west. It seems probable that it is an elongate dome, although it may be a terrace from which the bed rises to the north or to the west, or in both directions. The structure is more pronouncedly revealed by the contours on the base of the St. Louis limestone which reaches its maximum height slightly to the northeast of that of coal No. 2, or along a curved line extending from secs. 34 and 35 northwest to sec. 17, T. 3 N., R. 4 W. (Birmingham). From the east the St. Louis rises rather rapidly from 530 or 540 feet to 580 or 590 feet along this belt of elevated beds. Unfortunately there are no outcrops to the west which would show the altitude of the limestone farther in this direction, but the suggestions are that the bed dips to the west, beyond the belt of elevated strata, thus forming an elongated dome. If on the contrary the limestone rises to the west then the structure is a terrace rather than an elongated dome. At any rate, there is a sudden arrest of the rapidly rising limestone along this belt of elevated strata and there is a terrace on the steeper portion of the dipping limestone two miles east of Huntsville as shown on Plate I. The Huntsville uplift is represented graphically on the map by contours based on both the limestone and coal elevations.

RECOMMENDATIONS

Because the oil-producing bed is lenticular and is absent over considerable areas, the selection of favorable locations for drilling is fraught with more than the usual element of uncertainty. There is little doubt that in some of the areas described below, the sand is absent, and in this event there will be no accumulation of oil despite the favorable geological structure. It is hoped that the sand is present in at least a few of the areas listed below so that the combination of porous beds with favorable dips may be tested. The presence or absence of the sand cannot be predicted in advance of the drill.

The general plan of prospecting here proposed recommends the drilling of the more pronounced domes and anticlines first. Further testing will then depend on (1) the presence or absence of the Hoing oil sand, and (2) if present, whether it is (a) dry, (b) contains oil, or (c) contains salt water (see figure 13 and discussion on pages 26-29).

1. Ordinarily the dome on top of the terrace-like area in parts of secs. 7, 8, 17, and 18, T. 3 N., R. 4 W. would be recommended for drilling. However, the Henry Pearson well in the NW. $\frac{1}{4}$ sec. 19, which taps the Hoing sand horizon not more than 10 feet below the top of the dome, struck neither oil nor salt water. Wells in sec. 9, about one mile from the top of the dome and only slightly below it structurally, proved to be dry, and no salt water was found. A trace of oil was reported in the A. D. Lawton well in sec. 1, T. 3 N., R. 5 W. about 2 miles northwest of the dome mentioned. The Beard, Stark, and Gordon wells located from 2 to 4 miles southwest of the dome and structurally 25 to 30 feet lower showed neither oil nor salt water. Thus, the dome does not seem favorable. The only other location not tested is the top of the dome near the east side. A hole at the SW. cor. SE. $\frac{1}{4}$ NW. $\frac{1}{4}$ sec. 17, T. 3 N., R. 4 W. would test the oil horizon on the side of the dome from which the oil might have come.

2. In the shaded parts of secs. 26, 27, 34, 35, T. 3 N., R. 4 W. and secs. 2 and 3, T. 2 N., R. 4 W., as shown on the map, the beds lie approximately flat. They dip noticeably east, south, and north from this area. A well in the SE. cor. SW. $\frac{1}{4}$ SW. $\frac{1}{4}$ sec. 35, T. 3 N., R. 4 W. would test the sand on top of the terrace near its side where conditions are favorable for accumulation.

3. If the sand is present in the terrace mentioned under 2, and if it should prove devoid of oil and salt water as well, although sufficiently porous to hold these materials, it is suggested that a hole be drilled at the center of sec. 22, T. 3 N., R. 4 W. where the sand lies in a syncline and about 65 feet lower than in the top of the dome 2 miles northwest. It must be remembered that this test is not recommended until after the terrace described above is drilled.

4. The eastern end of a small terrace covers parts of secs. 14, 15, 22, 23, and 27, T. 3 N., R. 3 W. If the coal were present, its elevation would be about 596 on this terrace, about 35 feet lower than on the terrace described above. The beds dip north, east, and south, and although it is not a large feature, the terrace seems to merit at least one test which might well be located in the NE. cor. SE. $\frac{1}{4}$ sec. 22, T. 3 N., R. 3 W. There is considerable area to the east from which the oil might have been derived, and the flattening of the beds here is favorable for accumulation.

5. Outcrops at the east quarter corner of sec. 8 and in the NW. cor. sec. 21, T. 2 N., R. 2 W. (Buena Vista) show that the beds lie 20 or 30

feet higher than in the surrounding sections and probably show that a slight dome exists in the area shaded on the map, covering parts of secs. 4, 8, 9, 10, 16, 17, 20, and 21, T. 2 N., R. 2 W. A well in the center SW. $\frac{1}{4}$ sec. 9, would test the highest part of the dome. The center of the SW. $\frac{1}{4}$ sec. 16, would be an equally good location.

6. In the center of the SW. $\frac{1}{4}$ NE. $\frac{1}{4}$ sec. 13, T. 3 N., R. 2 W. the coal lies 590 feet above sea level, slightly higher than in the surrounding area. It is probable that the highest part of the arch lies $\frac{1}{4}$ to $\frac{1}{2}$ mile northeast of this outcrop, or at the northeast corner of sec. 13. The beds have a slight dip in all directions from this point. In point of fact, this feature is scarcely more than a terrace southeast of which the beds dip toward a pronounced syncline. To the north and northwest in the Macomb quadrangle the sand lies almost flat for 10 miles. A well near the NE. cor. sec. 13, T. 3 N., R. 2 W., would test the highest part of the low arch.

7. Outcrops in the northwest part of T. 1 N., R. 3 W. and in the northeast part of T. 1 N., R. 4 W. appear to reveal an anticline whose axis extends from about the center of sec. 5, T. 1 N., R. 3 W. southwest through the center of the west line of sec. 18. Field work has not been carried southwest of this point. Along the axis the beds lie 20 or 30 feet higher than at a distance of a mile or two on either side. If drilling is done along this anticline it is recommended that the wells be located slightly east of the axis as indicated.

8. In the area including parts of secs. 6, 7, and 8, T. 1 N., R. 2 W. and secs. 1, 11, 12, 13, and 14, T. 1 N., R. 3 W. the beds are arched into a dome. The dip on the south and east is greater than in other directions and can be seen without instrumental leveling in the valley of Crooked Creek. At the top of the dome the sand beds lie at least 50 feet higher than in the syncline which borders it on the southeast. North and west of the dome the dip is very gentle. Wells placed at the base of the bluff in the NW. $\frac{1}{4}$ sec. 7, T. 1 N., R. 2 W. or in the SE. cor. sec. 12 would test the dome slightly east of the top where accumulation might reasonably be expected.

9. A flat, elongate dome separated from the one just described by a syncline, exists in parts of secs. 9, 10, 11, 14, 15, 16, 20, 21, 22, 23, 27, 28, 29, 32, and 33, T. 1 N., R. 2 W. Outcrops here are not as numerous as would be desirable, but they indicate that from the area shaded on the map the beds dip slightly in all directions. Structurally, the beds in this dome lie about 30 feet lower than in the area described immediately above.

There is a considerable latitude for the selection of test wells in this dome but it is recommended that drilling be done first in the east half of the area shown by shading on the map. So far as structure is effective, wells in the SE. $\frac{1}{4}$ sec. 28, SW. $\frac{1}{4}$ sec. 22, and center of sec. 14, T. 1 N., R. 2 W. would be equally favorable.

10. Northwest of Frederick, in parts of secs. 6 and 7, T. 1 N., R. 1 E. and secs. 11 and 12, T. 1 N., R. 1 W., the beds lie flat; whereas east, south, and northeast there is a noticeable dip. Northwest of the area, exposures are lacking but it is thought that the beds lie almost flat. Judging from structure and without any knowledge of the sand or salt water, there is a possibility of some accumulation along the outer edge of this terrace. So far as can be determined from the outcrops a well in the SW. $\frac{1}{4}$ SW. $\frac{1}{4}$ of sec. 7, T. 1 N., R. 1 E. would be located properly with regard to structure.

If the normal oil-bearing horizon is barren of oil and salt water, it would be well to test the syncline which borders the terrace on the northeast and is outlined on the map by the 500-foot contour line. Whereas oil in synclines would be a new discovery for Illinois, it must be recognized that such accumulation is possible, and is well known elsewhere.

11. Along the north line of T. 1 S., R. 3 W., Brown County, the beds were found to rise noticeably toward the west, but field work was not continued west of sec. 4 of this township where the coal lies 583 feet above sea level or 60 feet higher than at the northeast corner of the township. It is hoped that field mapping may be continued south and west during the summer of 1915 to determine the position of the beds in that region.

LOCALITIES ALREADY TESTED

Of the wells drilled in the wild-cat territory to date, only two were located where the structure appears favorable. The Henry Pearson well near the center of sec. 19, T. 3 N., R. 4 W., (Birmingham), is near the highest part of the dome northwest of Huntsville, and since it is dry, it is believed that this well discredits the dome, although it is not located at the most favorable part, namely, the eastern side of the dome as mentioned under No. 1 of "Recommendations."

A new well completed April 15 by Mr. H. E. Cary southwest of Rushville in the NE. $\frac{1}{4}$ SW. $\frac{1}{4}$ sec. 11, T. 1 N., R. 2 W. is located at the northeast side of a dome described under No. 9 of "Recommendations." This well was drilled to 915 feet, which is about 75 feet below the top of the Trenton limestone. A small show of oil was noted near the top of the Trenton, but no mention of oil is made in the Niagaran at the horizon of the Hoing sand. A large amount of fresh water was found down to about 400 feet. Samples from the Trenton here show that it is not dolomitic and that it would probably not be a good reservoir for oil. The well is not regarded as favorably located as if it were two miles southwest, near the crest of the flat dome.

TABLE I.—Drill holes in the area south of the Colmar field

THE AREA SOUTH OF THE COLMAR OIL FIELD

Map No.	Section and quarterter	Company	Farm name and number	Surface elevation feet above sea level	Depth to bottom of top sand of sand to penetrated thickness of sand	Total depth in feet	Initial prodnc. (lbs.)	Remarks
16	1	Snowden Bros. & Co.	Hancock County, Augusta	Tow nship,	T. 3	N., R.	5 W.	965
25-NW	1	Beard	Burner	1	614	..	0	Dry
27-NW	1	Forbes, Forkner	W. S. Beard	1	655	..	..	No salt water
34-NW	1	Sliney, & Webber Co.	C. H. Stark	1	623	..	0	No sand
1-SE	1	Lancaster, Williamson	E. H. Gordon	1	..	..	0	Do. No sand
			A. D. Lawton	..	500	..	25	Do. No Hoing sand
							538	Trace of oil
19-NW	1	Lancaster, Williamson	Schuylerville, Birmingham	Tow nship,	T. 3	N., R.	4 W.	Dry
18-SW	1	Dennison	C. H. Wear	1	576	500	..	Dry
G. S. Hillyer	1	Henry Pearson	Henry Pearson	1	..	..	538	Dry
15-NE	1	Pure Oil Operating Co.	Schuylerville, Brooklyn	Tow nship,	T. 3	N., R.	3 W.	No salt water
32-NW	1	W. M. Morgan	G. S. Hillyer	1	527	..	0	No sand
J. H. Harbert	1		Schuylerville, Camden	Tow nship,	T. 2	N., R.	3 W.	Do. No sand
Ross Taylor	1		William Starr	1	477	479	-2	722
			Schuylerville, Huntsville	Tow nship,	T. 2	N., R.	4 W.	Dry
			J. H. Harbert	1	622	572	50	No sand
			Schuylerville, Woodstock	Tow nship,	T. 1	N., R.	2 W.	Do. No sand
			Ross Taylor	1	..	..	950	Dry

THE COLMAR OIL FIELD—A RESTUDY

By William C. Morse and Fred H. Kay

(In cooperation with the U. S. Geological Survey)

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ORIGINAL STUDY OF REGION AND PREDICTION OF OIL

The Colchester and Macomb quadrangles, in which the Colmar oil field is located, were examined in 1912 by Henry Hinds of the U. S. Geological Survey in cooperation with the State Geological Survey.

In order to learn the position of the beds, Mr. Hinds determined the elevation of coal No. 2 above sea level at a large number of places and where the coal has been eroded, levels were run to outcrops of beds whose distance below the coal is known. His maps, published as Plate I, Extract from bulletin 23, State Geological Survey, May 1914, show a pronounced doming of the strata between Plymouth and Colmar, the highest part lying in secs. 19 and 20, T. 4 N., R. 4 W., where the coal would be 720 feet above sea level were it not eroded. The dip toward the east and south is greater than that toward the north and west.

At the time of Mr. Hinds' field work no wells had been drilled closer than 4 miles from the top of the dome, but the favorable nature of the structure led him to suggest the possibility of petroleum accumulation in the dome. He also mentioned the existence of a smaller dome in sections 29 and 30 north of Macomb. The following quotation is taken from his report:

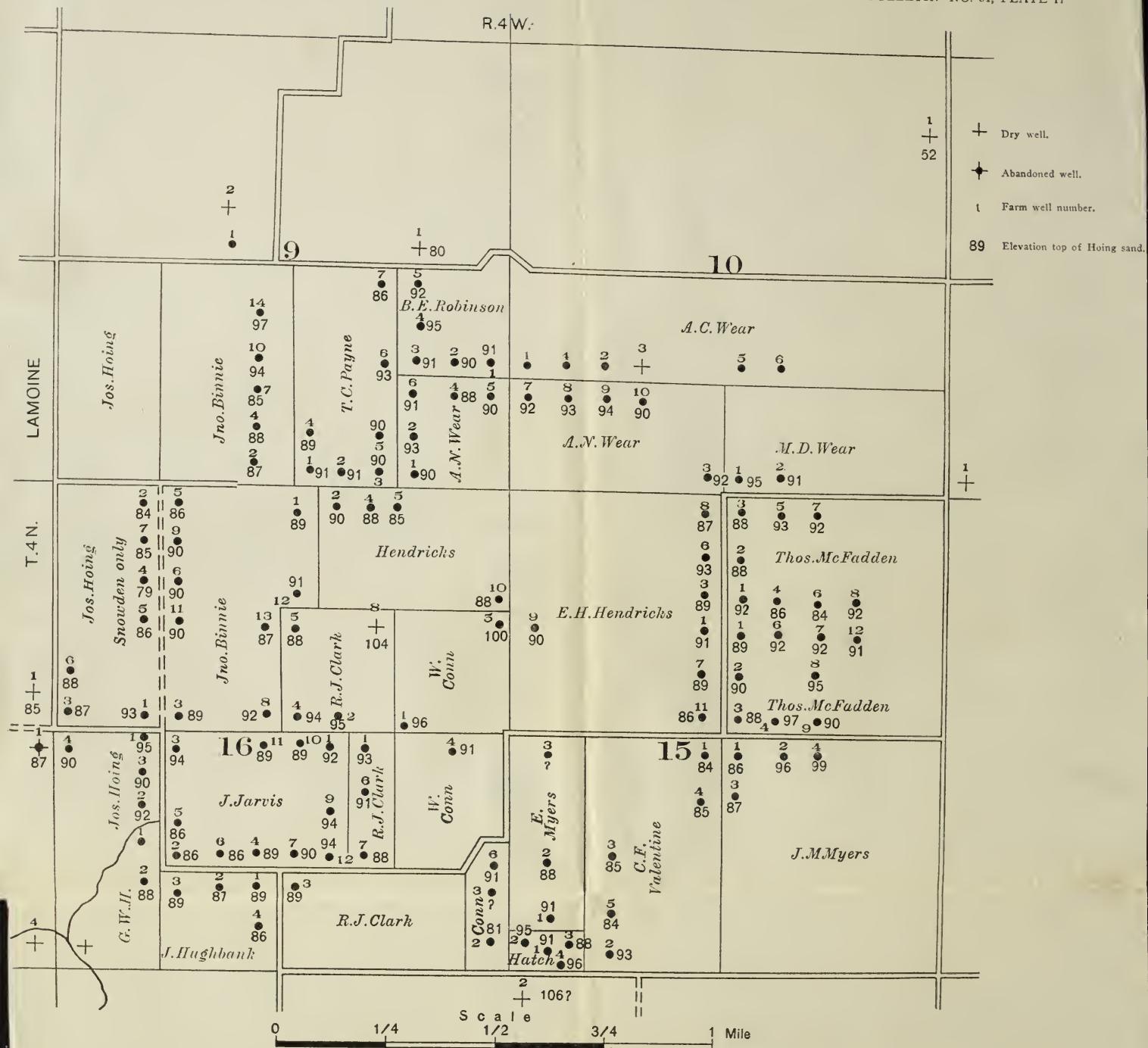
"Under those conditions (tilted beds saturated with salt water) accumulation takes place in the anticlines or arches or at the upper borders of dipping porous areas, (terraces [Editor]) where the porous rocks are at higher altitudes than in adjacent areas. A glance at the accompanying structure map will show that one such anticline lies two miles northeast of Plymouth only four miles northwest of well No. 4 near Birmingham. It is, perhaps, significant that the best reported showing of oil was in well No. 4, the one that is situated nearest the crest of this dome-shaped anticline, and it is unfortunate that at least one of the drillings was not made in the more promising territory. A similar but less pronounced dome exists near Macomb".¹

RESTUDY OF THE FIELD

Since the completion of Hinds' report in 1912 and its publication in May 1914, nearly 180 wells have been drilled in the region, of which more than 130 located in secs. 9, 10, 15 and 16, T. 4 N., R. 4 W. are productive (see Plate II). Roberts No. 1 well sec. 24, T. 4 N., R. 5 W. and a new well on the J. M. Wear farm SE. $\frac{1}{4}$ NW. $\frac{1}{4}$ sec. 14, T. 4 N., R. 4 W. are, up to date, the only commercially productive wells brought in outside of the four sections mentioned above.

The large amount of information made available by the drill rendered further study of the field desirable in order to determine (1) the position

¹Hinds, Henry, Oil and gas in the Colchester and Macomb quadrangles: Ill. Geol. Survey Extract Bull. 23, pp. 11-13, 1914.



Map showing location of wells in secs. 9, 10, 15, and 16, T. 4 N., R. 4 W. and elevations above sea level of the Hoing sand by William C. Morse

of the sand above sea level, (2) the relation of the position of the oil sand to that of the surface key rock, and (3) the conditions under which the oil accumulated. The additional field work by the senior author in 1914 consisted of the collection of drill records and instrumental leveling to determine the elevation of the wells above sea level.

BEDS PENETRATED IN DRILLING

Detailed descriptions of the formations are presented under the topic "Stratigraphy" in the first report of this bulletin. The following log of Griggsby No. 1 is presented, since it furnishes at a glance, knowledge regarding the beds down to and including a large part of the Trenton limestone. Most of the wells are drilled only to the normal oil-producing horizon at the base of the "second lime" as shown on the printed log.

Records from the adjoining region are very similar to this one, except that from some places, especially east and south of the field, they show a greater thickness of material above the "first lime." In the wells of the producing field the coal-bearing beds lying beneath the drift are almost entirely eroded; whereas farther east and south the "first lime" is found at a considerably greater depth and is overlain by shales, sandstones, and interbedded coals.

Drill record of Griggsby No. 1 well, W. ½ SE. ¼ T. 4 N., R. 4 W.

Elevation above sea level 576 feet

		Thickness Feet	Depth Feet
Surface deposits			
Soil and clay.....		25	26
Carboniferous system			
Mississippian series			
St. Louis and Osage groups			
Limestone, gray.....	10	36	
Mud	10	45	
Limestone, white, sandy.....	44	90	
Limestone, gray, water at 115 feet.....	55	145	
Limestone, white	35	180	
Kinderhook and Upper Devonian shales			
Mud, white.....	30	210	
Shale, brown	10	220	
"Slate," white, and mud.....	40	260	
Shale, brown	10	270	
"Slate," white, and shale.....	20	290	
Mud, white.....	21	311	
"Slate," white, sandy.....	67	378	
Shale, brown.....	7	385	
"Slate," white, sandy.....	15	400	
Devonian and Silurian systems			
Limestone, gray, show of oil 425 to 432 feet, "Second lime"	34	434	

	Ft.	In.
Ordovician system		
Richmond (Maquoketa) shale		
"Shale" and shale.....	187	621
Kimmswick-Plattin (Trenton) limestone		
Limestone, white.....	29	650
Limestone, brown.....	155	805

POSITION AND DEPTH OF OIL SAND

The Hoing oil sand was named from the first producing well in the field. It consists of well-rounded quartzitic grains and is lenticular in its occurrence. It lies on the Maquoketa shale, and at the base of the "second lime." It is believed to have accumulated in the lower parts of the Maquoketa surface and to have been reworked by the Niagaran sea. It represents, therefore, the basal part of the Niagaran. In places it is overlain by Niagaran dolomite and where the latter is eroded it is capped by the Hamilton limestone.

POSSIBILITY OF LOWER SANDS

The only other horizon in the Colmar field in which oil might reasonably be sought is the Trenton limestone which lies 100 to 200 feet below the Hoing sand and is separated from it by shale. Samples of the Trenton from the region of Colmar show that it is a pure limestone and does not tend to be sufficiently porous to act as a reservoir for oil and gas. The odor of petroleum and a small show of oil have been noted in places near the top of the formation, but no accumulation has been found. The Trenton was penetrated 184 feet in Griggsby No. 1 and it may be as much as 400 feet thick. In order to test all possible oil-bearing beds, the Trenton should be penetrated by a few holes in each area where conditions are favorable.

The St. Peter sandstone which underlies the Trenton, has never produced oil in Illinois. When penetrated in central and southern Illinois, it generally yields an abundant supply of highly mineralized water. The amount of salts increases toward the south.

POSITION OF HOING OIL SAND ABOVE SEA LEVEL

In order to show the parallelism between the beds outcropping at the surface and the oil sand, as well as the similarity in the folds affecting all of the beds down to and including the oil sand, Plate III has been prepared by printing in red, over the former map showing the position of the coal above sea level, a new set of contours which discloses the position and nature of the dome in the oil sand.

The detailed structure of the oil sand, the determination of which is made possible by the drilling of a large number of wells in a small area, confirms in an extremely satisfactory manner the value of ascer-

taining the structure of the outcropping beds prior to drilling. The crest of the dome, as shown by the coal and the St. Louis limestone, is identical

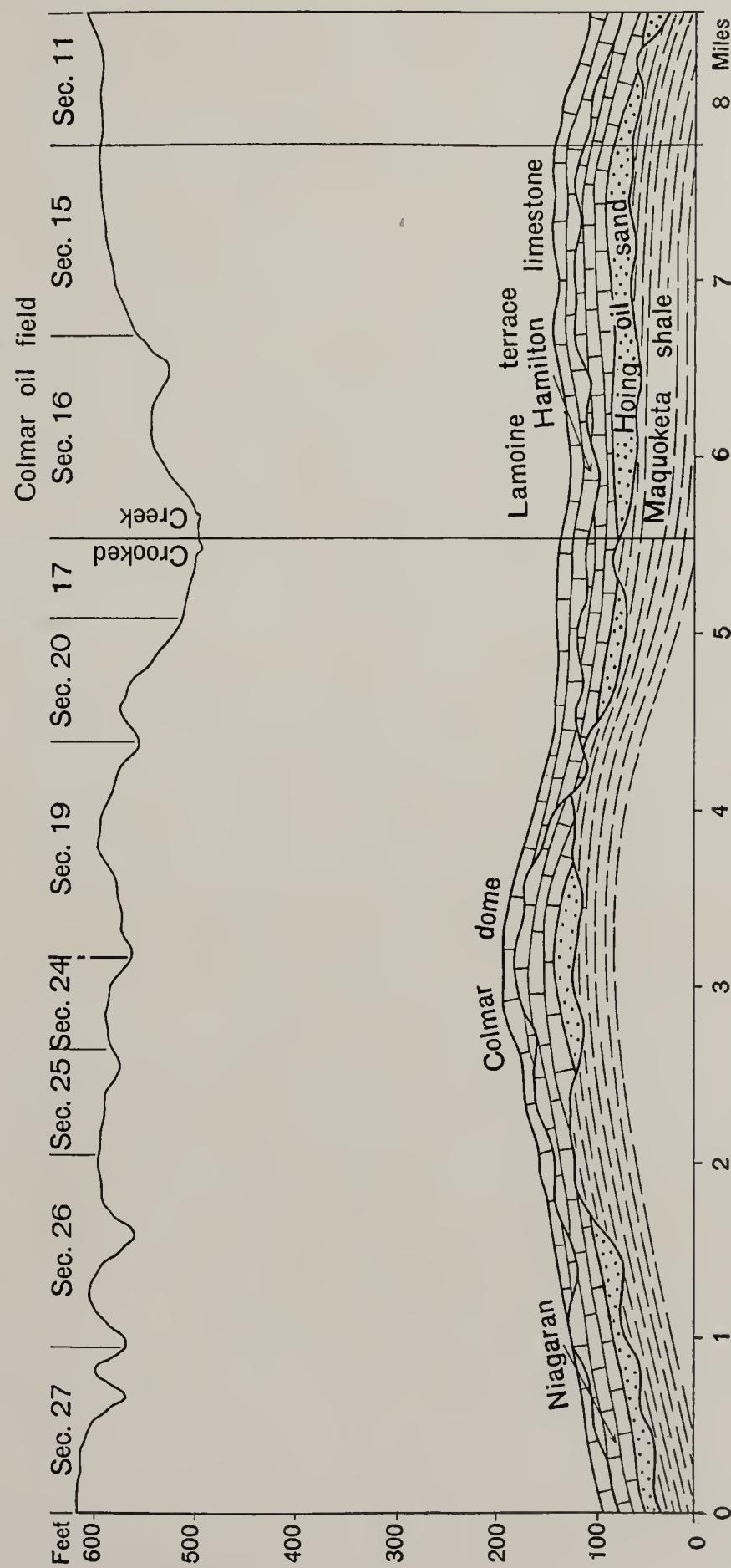


FIG. 13. Cross-section from SW. cor. sec. 27, T. 4 N., R. 5 W., to NW. $\frac{1}{4}$ sec. 11, T. 4 N., R. 4 W.
Note lenticular nature of sand.

in position with the apex as disclosed by the depth of the oil sand in the Collins well in the SE $\frac{1}{4}$ sec. 20., T. 4 N., R. 4 W.

It must be remembered that most of the region is covered by glacial deposits; and on the surface, instead of being able to see the bed rock over a large area, the geologist is limited to scattered outcrops for his observations, and it is to be expected that details of structure, such as terraces, may not be disclosed if outcrops are separated by considerable distances.

Mr. Hinds' coal contours and the contours on the oil sand by Mr. Morse, differ only in detail. The axis as shown by the sand extends east and west; whereas Mr. Hinds' map pictures it as a line extending a few degrees north of west. Figure 13 is a cross-section showing the position of the oil sand along a line from the SW. cor. sec. 27, T. 4 N., R. 4 W. to a point a short distance south of the center of sec. 11, T. 4 N., R. 4 W. Had the outcrops been as numerous and as closely spaced as are the oil wells in secs. 9, 10, 15, and 16, T. 4 N., R. 4 W. (Lamoine), the existence of the terrace would have been revealed in 1912. The beds at the top of the dome lie about 70 feet higher than on the terrace. No similar flat has thus far been disclosed by drilling in other parts of the Colmar dome. The beds dip away from the terrace in all directions except southwest.

CONDITIONS GOVERNING ACCUMULATION IN THE COLMAR FIELD

The accumulation of oil in the Colmar field, with the exception of Roberts No. 1 well mentioned later, is confined to the terrace on the northeast side of the dome. Most of the wells on the terrace reach the sand 85 to 95 feet above sea level. Griggsby No. 1 and Collins No. 1 located on the crest of the dome produced only a show of oil at elevations of 167 and 151 respectively; whereas Roberts No. 1, two miles west of the former wells had an initial daily production of 45 barrels from the Hoing sand at an elevation of 163 feet above sea level. However, the latter well is surrounded by dry holes and its production has declined rapidly to a few barrels.

The striking differences in elevation between the oil in Roberts No. 1 and in the main field seem to be the result of (1) the nature of the oil-bearing bed and (2) the erratic position of the salt water. The second feature is probably due in large measure to the first.

OIL-BEARING BED

In the main field the oil sand has an average thickness of 14 feet. It ranges from 5 feet to more than 30 feet but in its greater thicknesses certain horizons are more productive than others. Outside of the producing field, many wells show no porous bed capable of holding oil; after passing through the "second lime" the drill penetrates blue shale which probably is the top of the Maquoketa shale.

The oil sand exists in lenses and is surrounded completely by impervious beds, consequently it is natural for oil or salt water or both to exist in separated areas at different altitudes with barren areas between.

Collins No. 1 and Griggsby No. 1 wells produced only a show of oil and no salt water, but practically no porous beds were found at the base of the Hamilton limestone; whereas in Roberts No. 1, two miles west, 20 feet of porous beds are reported under the "second lime," and the oil is found in the upper 10 feet. A short distance down dip from Roberts No. 1 these same porous beds are saturated with salt water.

ERRATIC POSITION OF SALT WATER

Salt water is found on the terrace from 10 to 15 feet below the top of the sand. A. N. Wear Nos. 2, 4, and 6 and many of the wells on the Thomas McFadden leases yielded salt water the first day and considerable oil thereafter. Most of the wells lower down the dip in the vicinity of the terrace contain salt water if the sand is present. South and west of the terrace and in the higher part of the dome salt water fills the sands in the vicinity of Roberts No. 1 well 40 to 70 feet higher than the salt water in the terrace.

It is believed that the difference in elevation may be explained by the fact that the sand exists in two separated areas and that between the two the relatively non-porous limestone directly overlies the Maquoketa shale and the general result is an area of impervious strata separating two distinct lenses of porous, oil- and water-bearing beds. The conditions influencing accumulation, therefore, act independently in the two separated areas.

It is believed that a small lens of oil sand exists in the vicinity of Roberts No. 1. Sometime after it had been covered by the overlying formations, oil and salt water, probably from the Trenton limestone below, migrated upward through the Maquoketa shale and found lodgment in the porous sands. As long as the beds lay flat, there was probably no definite rearrangement of the oil and salt water; but after the "Coal Measures" were deposited, folding began which finally resulted in the formation of the Colmar dome, the Lamoine terrace, and the other structural features of the region.

Rearrangement began immediately, the final position of the oil depending on the proportion of oil and water in the porous material (see figure 13 and discussion). That the lens of oil-bearing sand at the Roberts wells is small is evidenced by the fact that the production of No. 1 has rapidly decreased from 45 barrels per day to only a few barrels, and there seems to be little hope of opening up a large production in the immediate vicinity.

The general mechanics of accumulation in the producing terrace were the same as those outlined above. The larger amount of oil in the terrace is due probably to the fact that the mass of oil sand of which that on the terrace is only a part, must be very large, and after the folding of the beds took place the terrace, being the highest part of the lens, received all of the oil by virtue of the difference in specific gravity between oil and salt water, and the high degree of saturation of the sands.

ORIGIN OF THE OIL

No quantitative analysis of the organic material in the beds of western Illinois are available to furnish a basis for assigning the origin of the oil to any single formation. However, field examination in that part of the State has emphasized the oily character of the Trenton. The odor of petroleum is distinctly noticeable at most places on the outcrop and recent drilling in Schuyler County has disclosed the same characteristics. In many places the Trenton is composed largely of shells which give evidence of the enormous amount of organic matter originally in the formation.

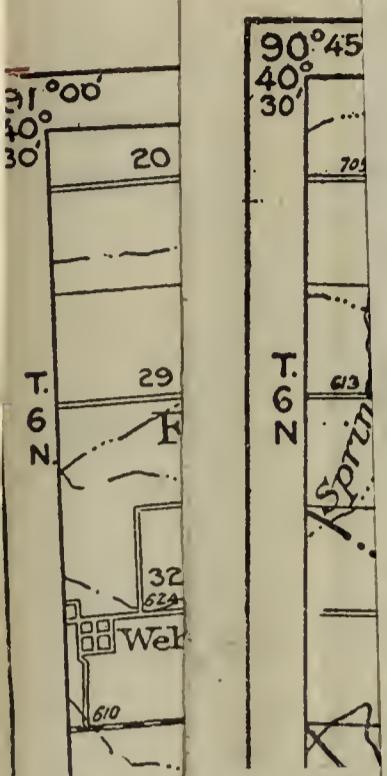
The "sweet" nature of the oil as mentioned in Extract from Bull. 23 has been a puzzling feature, since it is closely associated with limestones which generally produce the "sulphur" or "sour" oils. However, if the oil originated in the Trenton and finally found its way upward through the Maquoketa shales into the Niagaran, the sulphur would have been removed by filtration through the shale and "sweet" oil would result. Further work is necessary before the origin of the oil can be definitely assigned to the proper formation.

EXTENSION OF COLMAR FIELD

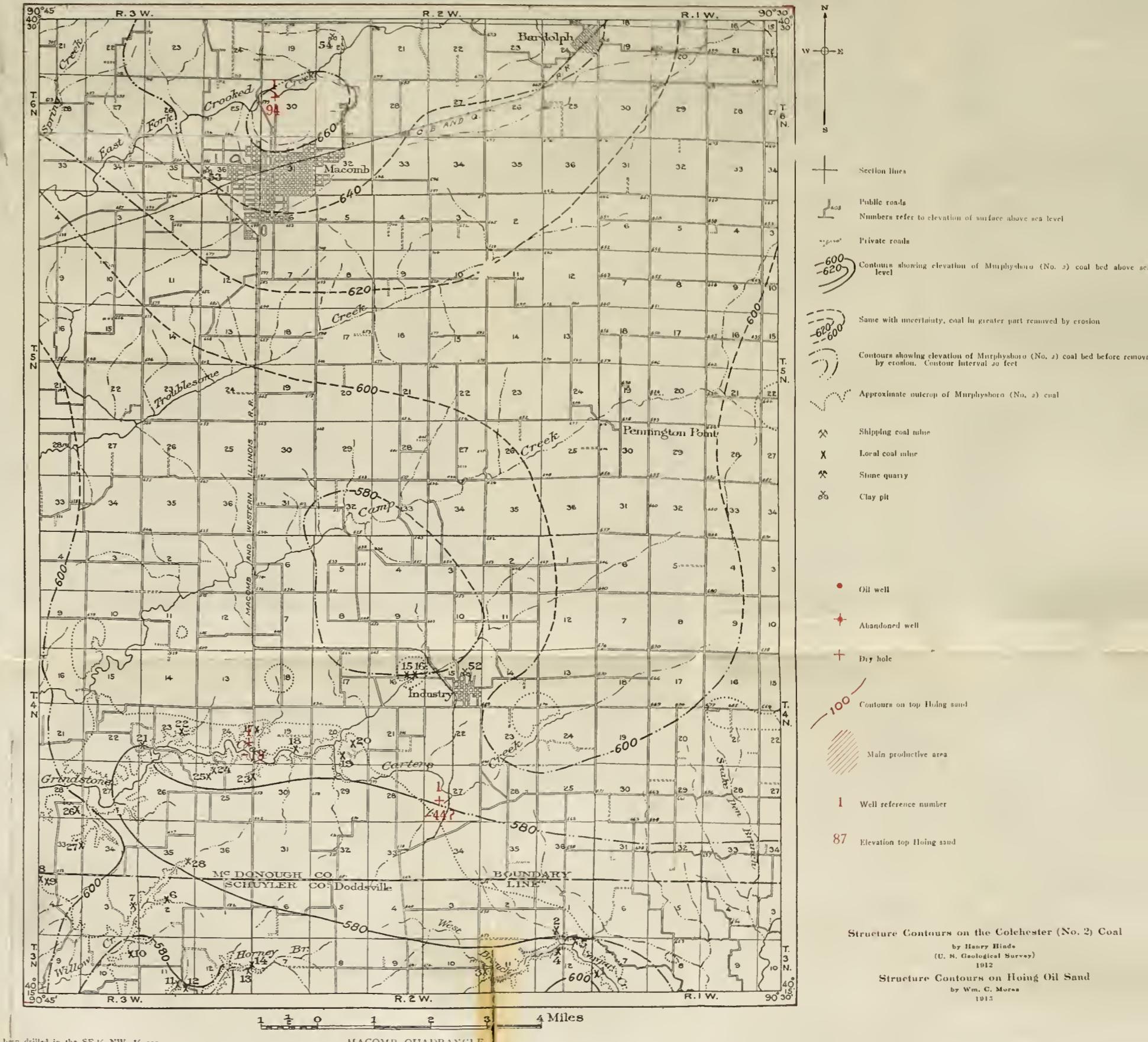
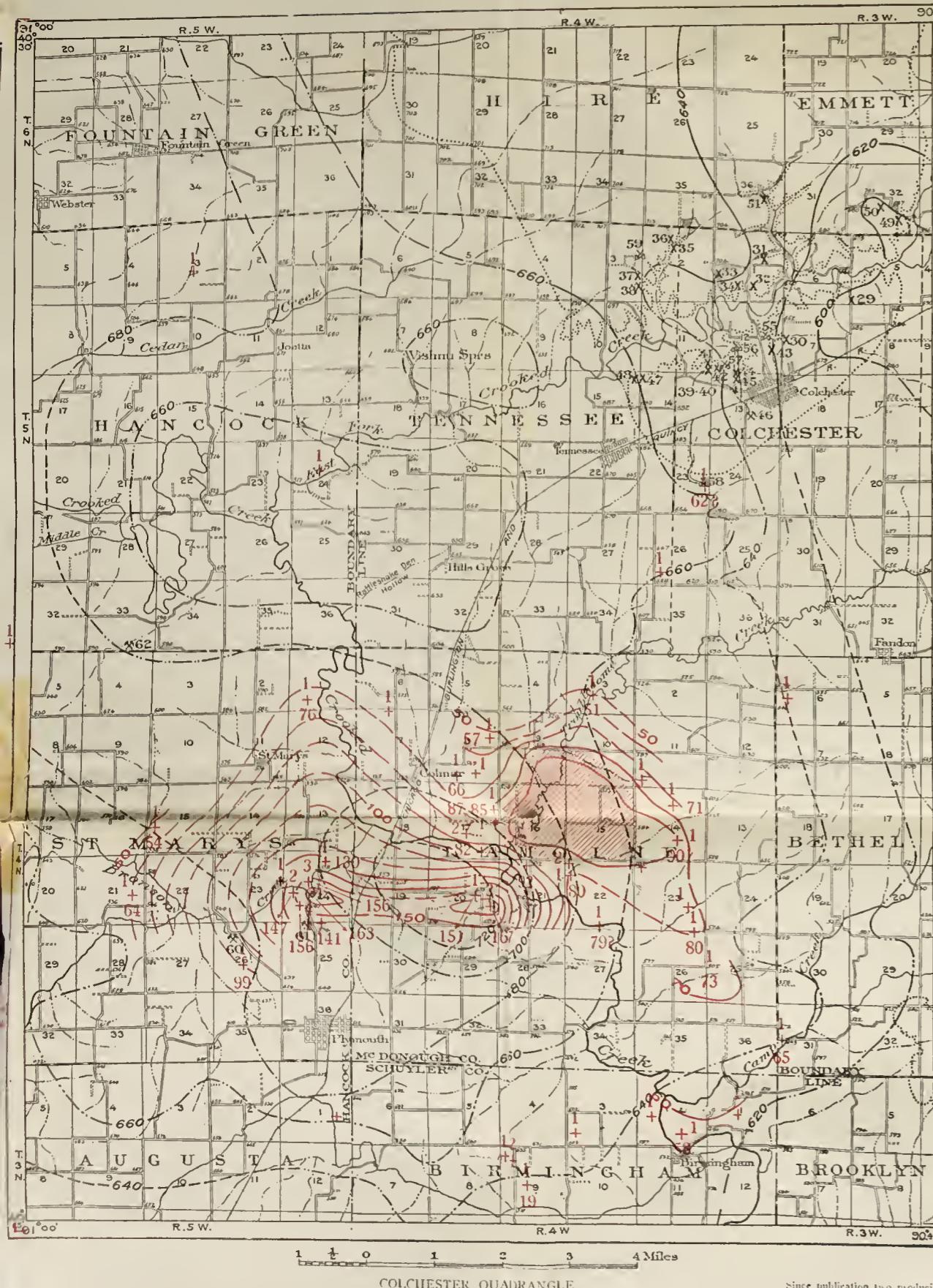
Up to date, practically the entire production has been from sec. 9, 10, 15, and 16, T. 4 N., R. 4 W. (Lamoine). Hartsook No. 1, NW. $\frac{1}{4}$ SE. $\frac{1}{4}$ sec. 14 contained no sand, but the bottom of the "second lime" which marks the top of the normal oil sand lies 90 feet above sea level or at the same elevation as the sand on the terrace one-half mile west. If the sand is present in any part of the SW. $\frac{1}{4}$ sec. 14, it should contain oil. A good well has now been brought in by the Ohio Oil Co. in the SE. $\frac{1}{4}$ NW. $\frac{1}{4}$ sec. 14, about one-half mile east of the McFadden wells, and there is every reason to believe that much of the area inside of the 90-foot contour in sec. 14 as shown on Plate III will prove to be productive.

The territory south and west of Colmar between the Bott well in the SW. $\frac{1}{4}$ sec. 1, T. 4 N., R. 5 W. and the Roberts wells in sec. 24 of the same township has not been sufficiently prospected. Wells should be drilled in the S. $\frac{1}{2}$ sec. 7 and the N. $\frac{1}{2}$ sec. 18, T. 4 N., R. 4 W.; also in the S. $\frac{1}{2}$ sec. 12 and the N. $\frac{1}{2}$ sec. 13, T. 4 N., R. 5 W. The sand was not present in the Bott well, but that fact does not condemn the territory mentioned.

SURVEY LOGI
U. S. RLIN, E.
GEORGIE, DIRE



1 +
+ +
Z +



Since publication two producing wells have been drilled in the SE $\frac{1}{4}$, NW $\frac{1}{4}$ sec. 14, and in the NE $\frac{1}{4}$, NE $\frac{1}{4}$ sec. 18, T. 4 N., R. 4 W.

MAP OF COLCHESTER-MACOMB QUADRANGLES

Structure Contours on the Colchester (No. 2) Coal
by Harry Hinds
(U. S. Geological Survey)
1912

Structure Contours on Hoing Oil Sand
by Wm. C. Morse
1915

when the possibility of a terrace and the lenticular nature of the sand are considered.

SUMMARY

Consideration of the information thus far developed in the Colmar oil field and surrounding territory leads to the following conclusions:

1. The oil sand and the overlying beds are essentially parallel to one another, and the determination of the "lay" of the oil sand in advance of drilling by leveling to outcropping beds is practicable.
2. The oil-bearing bed is a porous sandstone lying above the Maquoketa shale and at the base of the "second lime." A show of oil is noted here and there in what is probably the base of the Niagaran dolomite, but no important accumulation is known except in the sand.
3. The Maquoketa shale existed as land surface before the overlying beds were deposited and the sands that now contain the oil probably accumulated in the lower areas before or at the beginning of the submergence which caused the deposition of the Niagaran. Afterward the latter formation was exposed to erosion at the surface and in many places streams cut their channels not only down through the Niagaran but also into the Maquoketa shale; thereby removing any sand that may have existed at the base of the Niagaran. The Hoing sand, therefore, exists as separated lenses, the presence or absence of which at any given point cannot be predicted in advance of drilling.
4. The accumulation of petroleum depends (1) on the geological structure of each particular lens, i. e., the dip and strike of the beds and (2) the relative saturation of a given lens by oil and salt water.
5. The accumulation east of Colmar is on a flat or terrace in the sand, on the northeast side of a pronounced elongate dome. The crest of the dome is barren of oil except at the west end where a short-lived well was drilled, and later was surrounded by wells producing salt water, 70 feet higher than the oil in the main Colmar field.
6. The lens of which the producing sand on the terrace is a part is much larger than the one tapped by Roberts No. 1 at the west end of the dome, the amount of oil in any given lens being approximately proportional to the area and thickness of the lens.
7. The sand of the producing field is entirely separated from that at the Roberts wells, consequently there is no relation between the altitude of the oil and salt water at the two places.

8. Some extension of the field is to be expected around the edges of the present producing area, especially in the SW. $\frac{1}{4}$ and the S. $\frac{1}{2}$ of the NW. $\frac{1}{4}$ sec. 14 as mentioned under "Extension of the Colmar field". The possibility of favorable conditions west and south of Colmar between the Roberts and the Bott wells, is recognized (see text).
9. The oil may have originated in the Trenton limestone and migrated upward through the Maquoketa shales to the porous sand. Its "sweet" character may be due to filtration through almost 200 feet of shale which would have extracted from the oil most of its sulphur content.

Generalized section of rocks in Colmar oil field and surrounding territory

System	Series	Drillers' Interpretation	Formation	Character	Thickness
Quaternary		Surface		Alluvium—mostly clay and sand; confined to the present valleys. Loess—fine material between clay and sand, unconsolidated, thicker along bluffs of larger streams, weathers into vertical cliffs; most conspicuous along west bluffs of Illinois River. Drift—mixed clay, sand, gravel, and boulders, near surface on uplands.	Feet Variable 0-75 Average-25 In filled valleys-100+

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Carboniferous	Pennsylvanian	Coal-bearing formations	Carbondale	Principal coal-bearing formation of Illinois. Shales and sandstones containing thin beds of limestone, clay and coal. Exposed from coal No. 2 which is the base to a few feet above coal No. 5, a thickness of 130-140 feet. Coal No. 5 exists in a small area north of Rushville and Pleasant View. Entire formation eroded in places.	0-140+
			Pottsville	Includes beds from base of coal No. 2 to Mississippian limestones. Sandstone and shale, and some limestone, clay, and thin coal. Lies on old eroded land surface and is variable in thickness.	0-140
		"First lime"	St. Louis	Limestone, brecciated, generally blue but weathers yellow in places; contains scattered corals. Its hardness enables it to withstand erosion; blocks ring when struck with hammer.	0-30+
			Salem	Impure limestones having yellow tint. In many places difficult to distinguish from limy sandstone; whereas at other exposures the amount of shale increases and the formation is a mixture of limy shales, limy sandstone, and very impure limestone. Very difficult to distinguish contact with underlying Warsaw. Fossils scarce. Dull sound when struck with hammer.	30±
			Warsaw	Thin-bedded, impure limestone and shales, some of which are very fossiliferous. In some places considerable blue clay shale is present. Bryozoa abundant in shales; <i>Archimedes</i> in limestones.	30±
			Keokuk	Gray crystalline limestone, very fossiliferous, becoming shaly toward top. <i>Geodes</i> abundant.	30+
			Burlington	Limestone, generally cherty; not exposed in region.	?
Devonian	Upper Devonian	"Second lime"	Kinderhook	Shale, bluish gray, limy in places.	100±
			Unconformity	Shale, light to dark; contains many spores of <i>Sporangites</i> , a minute reddish fossil.	100±
			Hamilton	Limestone, gray, small amount sand, and some small crystals of pyrite. Usually not magnesian.	15-30
			Unconformity	Limestone, gray, crystalline, magnesian. Exists in separate lenticular masses; where it is not present Hamilton rests on Maquoketa shale. Show of oil in places near base.	0-20
Silurian	Hoing oil sand	Niagaran	Unconformity	Sandstone, quartzitic; grains well rounded. In lenses with no connection. Probably accumulated in depressions on Maquoketa surface. The producing bed of Colmar field and surrounding territory.	0-25 (Average in Colmar field 14)
Ordovician		Richmond (Maquoketa) Unconformity		Shales, bluish green; bluish mud when drilled.	180-200
		Kimmswick-Plattin (Trenton)		Limestone, gray, white, or brown. Very crystalline in places. Odor of oil not unusual. Not magnesian in Colmar field and area to south.	300-400
		St. Peter		Sandstone; generally saturated with highly mineralized water.	145-225 recorded

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TABLE 2.—List of wells in Colchester and Macomb quadrangles

Name of Company	Farm name and number	Surface elevation	Depth to sand	Elevation of top of sand	Thickness of sand penetrated	Total depth	Initial production (bbls.)	Remarks
1-SE 1	Lancaster, Williamson	A. D. Lawton	591	500	91	25	538	Dry Trace of oil
3-SW 1	Carthage Oil & Gas Co. (?)	Moore	..	..	..	..	670	Dry No showing of sand or oil
24-NW 1	Do.	James Samons,	1	..	..	..	534	Dry Showing of sand, no oil
31-SE 1	Do.	Marion Smith	1	*586	..	..	640	Dry No sand or oil
1-SW 1	Minor Bott	Hancock County, S	1	528	452	76	..	455 Penetrated 3 ft. of shale beneath 2d lime
15-SW 1	Carthage Oil & Gas Co.	S. M. Talbot,	1	534	480	54	558	Dry Showing of oil
21-SE 1	Do.	J. Mauk,	1	564	500	64	505	Dry Showing of sand, no oil, water
23-NE 1	Wireback & Co.	W. M. Babcock	1	531	..	..	..	Dry Hole full of water 5 feet in sand
24-NE 1	Ohio Oil Co.	A. McCormick,	1	512	..	..	..	Dry
SW 1	I. Roberts,	1	533	370	163	25	404	45
2	Do.	2	545	147	147	15	414	Dry
3	Do.	3	540	384	156	14	419	Salt water at 384
4	Do.	4	533	377	156	18	396	Dry Water
25-NE 1	Snowden Bros. & Co.	Aleshire,	1	601	460	141	480	Water at 465, show of oil
26-SW 1	Ohio Oil Co.	McCabe,	1	614	515	99	530	Dry Salt water and trace of oil 515-530

*Elevations obtained by hand level.

OIL INVESTIGATIONS

TABLE 2.—*Continued*

Section No.	Map No. of well	Name of Company	Farm name and number	Surface elevation	Depth to sand	Elevation of top of sand	Thickness of sand penetrated	Total depth	Initial production (bbls.)	Remarks
32-NW	1	B. R. Cannon,	1	562	..	..	..	..	Dry	
	2		2	553	..	..	..	..	Dry	
6-SW	1	J. B. & H. Hazlett	McDonough County, B	546	..	..	..	..
24-SE	1	Stover	Ethel	594	612	-18	..	603	Dry	Trace of oil sand 550-590
31-SW	1	Ohio Oil Co.	Township	502	437	65	..	638	Dry	Show of oil at 427
								645	Dry	Shale below 2d lime
23-SE	1	Ohio Oil Co.	McDonough County, C	602	540	62?	..	1050	Dry	Shale beneath 2d lime
27-SW	1	Macomb Industry & Lit- tleton R. R.	Johnson, McDonough County, I	615	659	-44(?)	..	678		
3-SW	1	Ohio Oil Co.	McDonough County, L	519	468	51	..	630	Dry	
7-NW	1	Ohio Oil Co.	W. B. Lawler, Sherman or McDonald, 1	575	..	..	..	..	Dry	
8-NE	1	E. R. Riggs (?)	J. W. Wybrant, Ino. Williams, 2?	561	504	57	13	519	Dry	Salt water 504-517
-SW	1		G. A. Falder, H. Bushnell,	505	439	66	10	449	Dry	
9-NE	..		W. F. Higgins,	518	..	..	..	..	Dry	
-NW	..			514	434	80	11	452	Dry	
				550	..	..	..	10	Not pumped	
				566	..	..	..	..	Dry	
	2	John Binnic,	2	511	424	87	12	453	60	
	4	(lease No. 2)	4	512	424	88	15	456	30	
	7	Do.	7	514	429	85	15	457	457	Salt water 1st day 15 barrels 2d day

THE COLMAR OIL FIELD

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TABLE 2.—*Continued*

Map No. of well	Section No.	Sand quarter No.	Name of Company	Farm name and number	Surface elevation	Depth to sand	Elevation of top of sand	Thickness of sand penetrated	Total depth	Initial product (bbls.)	Remarks
1	2	3	4	5	6	7	8	9	10	11	12
..	Ohio Oil Co.	John Binnie,	10	515	421	94	8	429	20	580	Dry
.	Do.	14	517	420	97	33	468	10	513	20	
-SE	J. E. Urschel & Co.	T. C. Payne,	1	512	421	91	9	430	Prod.	23	
.	Do.	2	511	420	91	6	426	Prod.	488	6	
.	Do.	3	513	423	90	10	433	Prod.	93	10	
.	Do.	4	513	424	89	9	433	Prod.	21	10	
.	Do.	5	513	423	90	12	435	Prod.	510	20	
.	Do.	6	514	421	93	9	430	Prod.	521	20	
.	Do.	7	514	428	86	8	436	Prod.	515	19	
.	B. E. Robinson,	1	514	423	91	9	432	42	515	19	
.	Do.	2	514	424	90	8	432	80	513	20	
.	Do.	3	513	422	91	8½	430½	120	513	20	
.	Do.	4	512	417	95	11	428	85	513	20	
.	Do.	5	515	423	92	10½	433½	Prod.	515	20	
.	A. N. Wear,	1	512	422	90	16	453	60	513	20	
.	Do.	2	513	420	93	19	456	Salt water 1st day at 433	513	20	
.	Do.	4	513	425	88	22	462	Salt water at 435	488	6	
.	Do.	5	512	422	90	24	462	8	510	10	
.	Do.	6	514	423	91	23	455	Prod. Salt water 1st day	521	20	
10-NE	Do.	1	567	515	52	10	580	10 bbls. oil 2d day	515	19	
-SW	Do.	3	573	481	92	17	513	Water at 515	488	6	
.	Do.	7	542	450	92	23	510	10	521	20	
.	Do.	8	567	474	93	21	510	10	515	20	
.	Do.	9	576	482	94	21	521	20	515	19	
.	Do.	10	566	476	90	19	515				

OIL INVESTIGATIONS

TABLE 2.—Continued

Map No. of well	Section No.	And quarter and quarter	Name of Company	Farm name and number	Surface elevation	Depth to sand	Elevation of top of sand	Thickness of sand penetrated	Total depth	Initial production (bbls.)	Remarks
.	Caldwell & Reuben	A. C. Wear,	1	569	..	..	..	..	..	..	Prod.
.	Do.	2	562	..	..	..	..	..	..	..	Prod.
.	Do.	3	555	..	..	..	..	..	..	..	Dry
.	Do.	4	575	..	..	..	..	..	..	..	Prod.
.	Do.	5	579	..	..	..	..	..	..	..	Prod.
-SE	Do.	6	578	..	..	..	..	..	..	..	Prod.
.	Ohio Oil Co.	1	572	477	95	95	19	19	509	40	Salt water 490-496
.	Do.	2	577	486	91	91	18	18	518	18	
1- SW	Caldwell & Reuben (?)	A. C. Wear,	7	*583	..	..	..	..	..	..	Dry
14-NE	Ohio Oil Co.	J. M. Wear,	1	595	524	71	18	18	543	Dry	No sand. Water 1st day
-SE	Do.	M. Hartsook,	1	583	493	90	..	..	778	Dry	Salt water 1st day
15-NE	J. B. & W. H. Hazlett	Thos. McFadden	1	576	484	92	18	18	508	Prod.	Present 8 barrels
.	Do.	2	578	490	88	88	16	16	516	Prod.	Water 1st day
.	Do.	3	576	488	88	88	9	9	497	Prod.	Present 8 barrels
.	Do.	4	577	491	86	86	5	5	496	Prod.	All salt water 1st day
.	Do.	5	575	482	93	93	10	10	492	25	Present 6 barrels
.	Do.	6	578	494	84	84	8	8	502	Prod.	Salt water at 492
.	Do.	7	576	484	92	92	11 1/2	11 1/2	495 1/2	50	Salt water at 495 1/2
.	Do.	8	580	488	92	92	12	12	517	50	Salt water at 500
.	Lamoine Oil & Gas Co.	1	571	482	89	89	14	14	496	150	Salt water at 496
.	Do.	2	559	469	90	90	15	15	489	80	Salt water at 480
.	Do.	3	558	470	88	88	15	15	489	100	

THE COLMAR OIL FIELD

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TABLE 2.—Continued

Name of Company	Farm name and number	Map No. of well	Section No.	Sect. and quarter	Surface elevation	Depth to sand	Elevation of top of sand	Thickness of sand penetrated	Total depth	Initial production (bbls.)	Remarks
					Do.	Do.	Do.	Do.	Do.	Do.	Do.
Lamoine Oil & Gas Co.	Rhos. McFadden,			-NW	4	576	479	97	14	500	100
	Do.				6	573	481	92	12	493	100
	Do.				7	576	484	92	18	513	100
	Do.				8	578	483	95	16	506	125
	Do.				9	576	486	90	16	502	100
	Do.				12	572	481	91	15	500	100
Ohio Oil Co.	E. H. Hendricks,			-SW	1	574	483	91	13	511	75
	Do.				3	577	488	89	15	519	75
	Do.				6	578	485	93	14	514	35
	Do.				7	573	484	89	12	515	25
	Do.				8	573	486	87	14	516	20
	Do.				9	560	470	90	11	497	10
	Do.				11	548	462	86	8	470	15
	Do.									507	6
C. F. Valentine,					1	560	476	84	14	476	4
					2	*531	438	93	12	514	Prod.
					3	*563	478	85	15	485	Prod.
					4	540	455	85	14	508	Prod.
					5	549	465	84	14	450	Prod.
					1	*523	432	91	12	486½	Prod.
John W. Caldwell					2	*565	477	88	..		
					3					75	
Hatch,	Gem City Oil Co.				1	*518	427	91	13	440	Prod.
	Do.				2	*533	438	95	10	448	Quit in sand
	Do.				3	*539	451	88	9	460	Do.
	Do.				4	*521	425	96	11	438	Prod.
J. M. Myers,	Lamberton & Barker				1	576	490	86	9	499	Quit in sand
										60	Salt water at 495

TABLE 2.—*Continued*

Section No. and quarter and company	Map No. of well	Name of Company	Farm name and number	Surface elevation	Depth to sand	Elevation of top of sand	Total depth	Thickness of sand penetrated	Initial production (bbls.)	Remarks
..	..	Lamberton & Barker	J. M. Myers,	2	578	482	96	13	510	No water
..	..	Do.		3	562	475	87	13	491	Salt water 486-488
..	..	Do.		4	577	478	99	11	499	No water
16-NE	..	Ohio Oil Co.	John Binnie, (lease No. 2)	1	511	422	89	9	431	85
..	..	Do.	E. H. Hendricks,	12	511	420	91	10	446	5
..	..	Do.		2	511	421	90	9	445	75
..	..	Do.		4	512	424	88	9	448	60
..	..	Do.		5	509	424	85	11	449	35
..	..	Do.		10	*553	465	88	10	485	10
..	..	Do.		2	525	430	95	13	443	Prod.
..	..	Do.	R. J. Clark,	4	509	415	94	15	430	30
..	..	Do.		5	510	422	88	8	431	Prod.
..	..	Do.		8	549	445	104	3	500½	Dry
..	..	Do.		1	*552	456	96	9	465	100
..	..	Do.	Conn,	5	*563	463	100	12	475	Prod.
..	..	Do.		1	507	414	93	7	421	55
..	..	Do.	Jos. Hoing,	2	506	422	84	5	427	20
..	..	Do.		3	508	421	87	6½	427½	Prod.
..	..	Do.		4	508	429	79	1½	430½	Prod.
..	..	Do.		5	508	422	86	7	429	5
..	..	Do.		6	508	420	88	9	429	17
..	..	Do.		7	507	422½	84½	8	432½	Prod.
NW	..	Snowden Bros. & Co.								
..	..	Do.	John Binnie, (lease No. 2)	3	507	418	89	14	432	40
..	..	Ohio Oil Co.		5	507	421	86	11	444	20
..	..	Do.		6	508	418	90	14	448	20

THE COLMAR OIL FIELD

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TABLE 2.—Continued

Name of Company	Farm name and number	Surface elevation	Depth to sand	Elevation of top of sand	Total depth	Thickness of sand penetrated	Penetration in feet	Initial production (bbls.)	Remarks
Ohio Oil Co.	John Binnie, (lease No. 2)	8 9 11 13	509 508 508 508	417 418 418 421	92 90 90 87	15 11 18 11	449 442 452 448	30 20 8 10	
Snowden & Ohio	Jos. Hoing,	1	508	413	95	7	420	30	
	Do.	2	508	416	92	11	427	35	
	Do.	3	506	416	90	5½	421½	20	
	Do.	4	507	417	90	11	439	5	
Cleveland Producing Co.	C. W. Hughbanks,	1	506	..	..	..	422½	30	
	Do.	2	509	421	88	6	427	Prod.	
	Do.	1	548	459	89	7	466	75	Quit in sand
	J. T. Hughbanks,	2	512	425	87	6	431	35	
	Do.	3	508	419	89	7	426	35	Quit in sand
	Do.	4	538	452	86	..	452	Prod.	
	J. Jarvis,	2	512	426	86	9	448	12	
	Do.	3	508	414	94	16	445	30	
	Ohio Oil Co.	4	545	456	89	12	483	20	
	Do.	5	516	430	86	15	460	20	
	Do.	6	541	455	86	10	482	20	
	Do.	11	520	431	89	12	457	15	
	Do.	1	544	452	92	5	457	65	
	-SE	7	546	456	90	10	481	20	
	Do.	9	568	474	94	14	504	15	
	Do.	10	529	440	89	13	470	18	
	Do.	12	558	464	94	10	488	12	

-SE

TABLE 2.—Continued

THE COLMAR OIL FIELD

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TABLE 2.—Continued

Map No. of well	Section No.	Sect. quarter No.	Name of Company	Farm name and number	Surface elevation	Depth to sand	Elevation of top of sand	Total depth	Initial production (bbls.)	Remarks	McDonough County, Tennessees				
											Thickness of sand penetrated	Thickness of sand penetrated	Macomb	Township	ip	Dry
30-NW	1	Macomb City													
26-SW	1	Ohio Oil Co.	McDonough County, Tennessees	*594	500	94	..	..	586	..	975	..	..	..	Dry
1-SW	..	Schuyler Oil & Gas Co.	A. H. Carson,	1	634	..	..	..	..	..	..	..	..	..	Dry
2-SW	..		J. H. Myers	1	499	..	..	..	..	..	..	..	..	..	Dry
-SE	1		W. B. Manlove,	3	*513	..	..	..	..	..	..	..	..	..	Shot at 435. Est. 2 bbls.
3-SW	1	Ohio Oil Co.	W. H. Moon,	1	506	448	58	15	670	..	..	..	..	..	Showing of oil 430-432.
9-NW	1	Schuyler Oil & Gas Co.	Sol. Twidwell,	1	600	570	30	25	600	..	..	..	..	..	No salt water
	2		W. B. Manlove,	2	625	..	..	..	815(?)	..	..	..	..	..	Small amount of gas
	1			4	*627	..	..	..	1608(?)	..	..	..	..	..	Water at 60 & 700 or 750
	2								1847 $\frac{3}{4}$	..	..	..	..	..
	1								1125(?)	..	..	..	..	..	Heavy flow of mineral water at 950 (?)
															Showings of oil at 511, 750, and 900

THE ALLENDALE OIL FIELD

By John L. Rich

(In cooperation with the U. S. Geological Survey)

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INTRODUCTION

AREA AND LOCATION

In August, 1912, a successful well opened up the Allendale oil field in T. 1 N., R. 12 W., Wabash County, Illinois. The field at present is small, about one and one-half miles long by three-fourths of a mile wide lying in parts of secs. 3, 4, 9, 10, and 16. The principal producing area lies in secs. 4 and 9.

The Allendale field lies isolated about 8 miles southwest of the newly developed continuation of the Lawrence County field at St. Francisville. It is developed on a minor north-south fold or dome lying upon the western flanks of the larger fold which gives rise to the main Crawford and Lawrence county fields. Allendale, a small village on the Cleveland, Cincinnati, Chicago and St. Louis Railway, lies about 2 miles southeast of the field and is the nearest point of supply.

The purpose of the recent investigations of this field was to determine the structure of the field, its relation to the nearby larger fields, and the character and stratigraphic position of the producing sands, in order to ascertain the possibility of further development of the field, and the location of areas where future prospecting is most likely to be successful.

ACKNOWLEDGMENTS

The preparation of this report has been greatly facilitated by the kindly cooperation of the officials of the various oil companies operating in the Allendale field. To Mr. J. K. Kerr, general superintendent, and to Mr. Ora Fess, local field superintendent of the Ohio Oil Co.; to Mr. A. E. Baldwin and Mr. M. A. Arvm of Snowden Bros. & Co.; and to Messrs. Tyler Andrews and A. D. Smith of the Sian Oil Co. especial acknowledgment is due. Prof. T. E. Savage of the State Geological Survey gave helpful consultation regarding questions of stratigraphy.

HISTORY

The first successful well in the Allendale field was drilled late in July, 1912, on the farm of Adam Biehl in the NE. cor. SE. $\frac{1}{4}$, sec. 4. This well having an initial production of 650 barrels proved to be one of the best in the field and created great excitement at the time. A rush followed, and within a few months many more wells had been completed.

The accompanying table presented graphically in figure 15, shows the number of wells completed during each month since the opening of the field and the number of these which were successful.

OIL INVESTIGATIONS



FIG. 14. Map showing location of Allendale oil field.

TABLE 3.—*Monthly development of Allendale field*

Month	Wells drilled	Number of producers	Month	Wells drilled	Number of producers
1912—June	1	0	July	3	3
July	0	0	August	3	1
August	1	1	September ..	0	0
September ..	4	2	October	2	1
October	14	12	November ..	2	2
November ..	8	5	December ..	1	1
December ..	8	3	1914—January	0	0
1913—January	9	2	February ...	2	2
February ...	2	1	March	0	0
March	4	2	April	0	0
April	1	1	May	2	0
May	4	3	June	2	1
June	3	2		—	—
Total	76				45
Percentage of total number productive.....	59				

During the four months from October, 1912, to January, 1913, inclusive, more than one-half the total number of wells in the field was completed. As is indicated, a discouraging number of those completed during November, December, and January were dry holes (see figure 15). This was due to the fact that of the wells drilled during the months named, a large proportion were put down around the outside of the producing area for the purpose of testing the extent of the field. These unsuccessful wells showed clearly that the productive area would be small. Since January, 1913, the number of wells drilled each month has steadily decreased. Since February, 1913, it has never exceeded four, and since August of that year it has averaged only about one a month. Since the limits of the field have become fairly well known the proportion of successful wells has increased to about 60 per cent.

TOPOGRAPHY

The Allendale field is located in a gently rolling area of slight relief situated on the southwestern slope of a group of low hills about sixteen square miles in extent, which rise somewhat less than 100 feet above surrounding alluvial lands. Elevations range from 430 to 510 feet above the sea, but all slopes are gentle and the valleys are broad and open. The irregularities are nowhere sufficiently great to interfere with the hauling of materials and supplies, or with the installation of the apparatus used in pumping the wells.

STRATIGRAPHY

UNCONSOLIDATED ROCKS

The bed rocks of the region are everywhere concealed by a mantle of unconsolidated clays, sands, and gravels known as the glacial drift, and

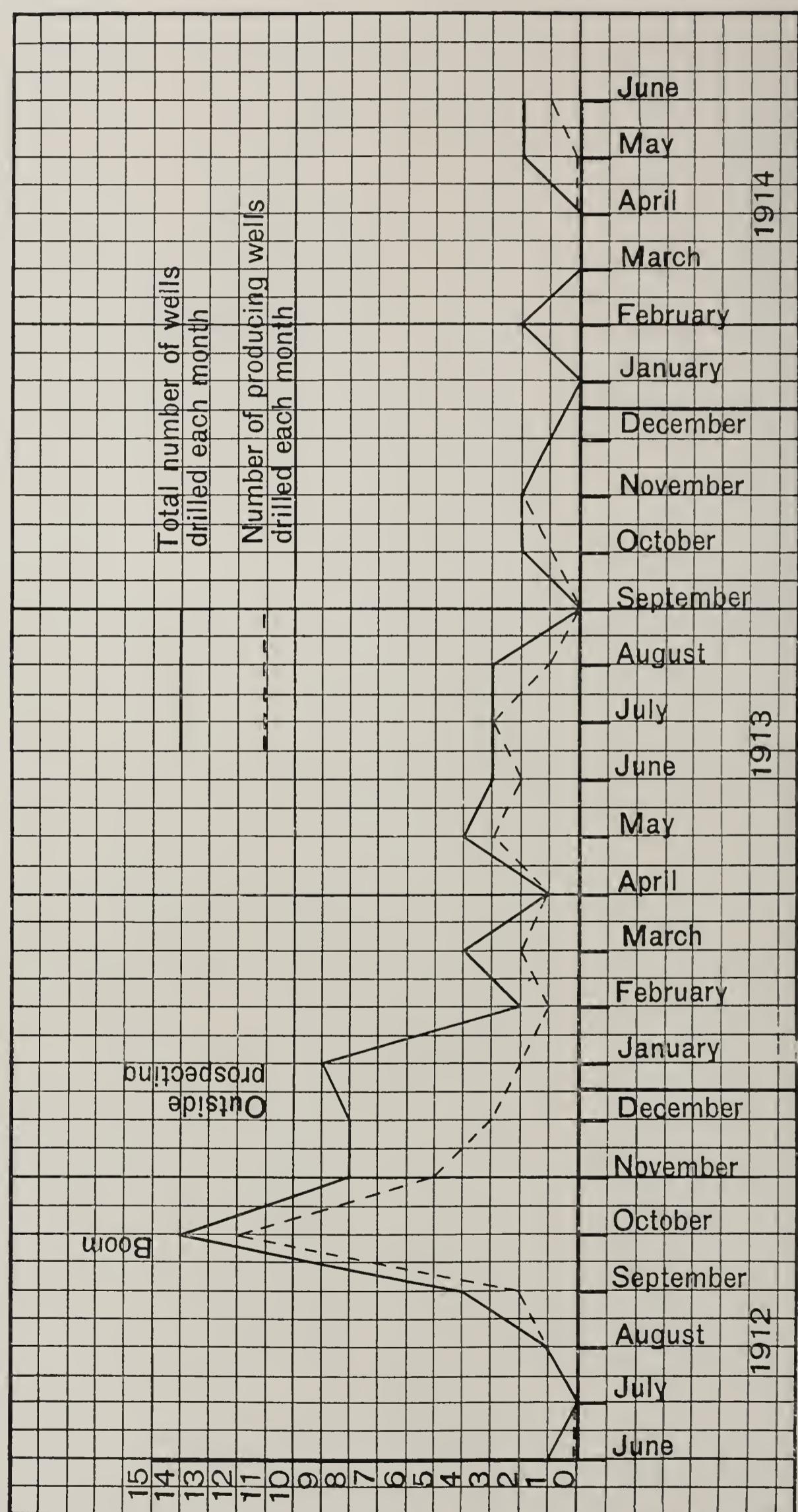


Fig. 15. Graphic table showing wells completed by months and number productive.

by fine wind-blown "loess". This mantle, as revealed in the wells, averages about 45 feet in thickness, but it varies from about 15 feet to somewhat more than 100 feet. In general it is thinnest on the higher ground and thickest in the valleys and on the broad flats which surround the field. On the uplands it consists of yellowish, loess-like clay and sand, with blue "hardpan" (glacial till) in places at the base. The top portion of this yellow loam is loess, a fine dust which at an earlier period was deposited by the winds.

CONSOLIDATED ROCKS

Down to the greatest depths reached by the wells the underlying rocks of the region belong to the two divisions of the Carboniferous system: the Pennsylvanian above, and the Mississippian below. About 1300 feet of the Pennsylvanian rocks has been encountered, but only the upper part of the Mississippian series has been penetrated.

PENNSYLVANIAN SERIES

The Pennsylvanian rocks consist of a series of shales alternating with sandstones and occasional thin lenses of limestone. The latter, however, comprise only a relatively small part of the section. The sandstones and shales occur in beds of varying thickness ranging from only a few feet to 200 feet or more.

The Pennsylvanian series in this State is commonly separated into three formations: the McLeansboro at the top, extending down to the top of coal No. 6; the Carbondale, including the strata from the top of coal No. 6 to the base of coal No. 2; and the Pottsville, extending from the latter to the base of the Pennsylvanian series. From the records of the wells in the Allendale field it is impossible to draw any sharp lines of distinction between these three formations. The horizon of coal No. 6 may be recognized in a general way at 500 to 600 feet below the surface, but the horizon of the Murphysboro (No. 2) coal cannot be so definitely distinguished.

The most noteworthy feature of the Pennsylvanian rocks is their variability both horizontally and vertically. Lenses of sandstone more than 50 feet thick in one well may be absent in nearby wells. In fact, so great is the variability of these beds that no close correlations between them can be made.

A few beds are fairly persistent and may be recognized in a large proportion of the logs. In almost all the wells a water-bearing sandstone is found at 100 to 200 feet below the surface. Another water-bearing sand, occasionally appearing as two sands a short distance apart, is usually found at about 600 feet. This, however, is not sufficiently persistent to be recognizable in all the wells, nor sufficiently definite in its position

to serve as a basis for contouring. At the base of the Pennsylvanian series is a massive white sandstone (Pottsville) which averages about 150 feet in thickness and may be recognized in nearly every well. This, the most easily identifiable bed in the whole series, is correlated with the Buchanan sand of the Lawrence County field.

In addition to the sands, one or more beds of coal are recorded in several of the logs. One of these coals, lying between 500 and 600 feet below the surface, is thought to represent coal No. 6 (Herrin or Belleville). However, the records are too few in number, and they lack sufficient agreement to make this correlation certain.

MISSISSIPPIAN SERIES

Beneath the heavy sandstone at the base of the Pottsville lies a series of thin limestones and shales with occasional thin beds of sandstone, the latter increasing in thickness and importance toward the base of the section penetrated by the wells. This is the Chester group. The exact thickness of the Chester in the Allendale field is uncertain, but is at least 700 feet, since two wells on land of John H. Schafer and C. F. Adams have penetrated Chester strata to that depth without having reached its base. Several thin beds of red shale mark the lower part of the formation in nearby fields. These were found in both of the deep wells mentioned; in one at a depth between 1915 and 1950 feet; in the other between 1830 and 1910 feet, indicating that the bottoms of the wells at about 2000 feet must be near the base of the Chester.

STRATIGRAPHIC POSITION OF THE OIL SAND

The producing sand in the Allendale field, commonly known as the Biehl sand from the farm on which the oil was first struck, lies about 190 feet below the top of the Chester. This interval varies between 130 and 250 feet, probably on account of the uneven upper surface of the Chester, which was irregularly eroded before the Pottsville formation was deposited above it. From its stratigraphic position it appears that the Biehl sand should be correlated with the Kirkwood sand of the Lawrence County field.

No oil has been reported from any of the sands in the Pottsville, or in the Chester below the general level of the Biehl sand. There is, however, evidence that a few of the wells on the borders of the field secure their oil from sands a few feet lower than the Biehl sand. Such lower sands seem to be local lenses which carry the oil in places where the regular sand is not present.

CHARACTERISTICS OF THE OIL SAND

The oil appears to have accumulated in a single bed of sandstone in all parts of the field except at the few wells mentioned immediately

1930-1931

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D.S. Ravatt

C. Hershey



above where, because of the irregularity in depth at which the oil was reported, it appears that it must be in beds or lenses slightly lower in the series. The principal wells showing this discrepancy are W. H. Armstrong No. 3 and C. Smith No. 9, at the southern end of the field.

In most of the wells the oil sand varies from 20 to 30 feet in thickness, but a maximum of at least 40 feet is known. A marked local thinning of the sand was disclosed in the wells near the NE. $\frac{1}{4}$ NW. $\frac{1}{4}$ sec. 9.

The sand is described as brown or light brown, the color probably being due merely to oil stain. It is usually soft, though in a few wells it is reported as hard. Wells in sand of the latter type yielded only small quantities of oil, even though located where the structure is favorable.

In most of the field the oil sand is overlain by a bed of limestone 20 to 30 feet thick; however, in McMillen Nos. 6, 7, and 8, in the NW. $\frac{1}{4}$ SE. $\frac{1}{4}$ sec. 9, shale forms the cap rock.

STRUCTURE

STRUCTURAL FEATURES OF THE AREA

The structure or the "lay" of the oil sand is represented on the map (Plate IV) by means of contours drawn on the top of the Biehl sand. These contours, which are drawn for every 10 feet represent the elevation of the top of the sand above a plane 1500 feet below sea level. Each contour connects points on this sand having the same elevation above this datum plane.

The depth of the top of the sand below the surface of the ground in each well may be found by subtracting the number of the contour passing through the well from 1500 and then adding the elevation of the well above sea level. Thus if a certain well is on the 490-foot contour and the elevation of its mouth is 468 feet, then $1500 - 490 = 1010$, $1010 + 468$ gives 1478 as the depth of the top of the oil sand below the surface of the ground.

The map shows that the Allendale field is located on the top of a distinct arch or dome, the main axis of which extends in a north and south direction, and that from the top of this elevated area the rocks dip away in all directions. Closer examination reveals certain minor features of the structure of the arch which deserve special mention since they play a large part in determining the detailed distribution of the oil.

Along the eastern side of the arch, and forming its crest, is a prominent anticline, broad in the middle and narrowing at both ends, which extends north and south through the eastern parts of secs. 4 and 9. The western limit of the higher parts of the arch is marked by a smaller, less distinct fold extending from near the center of sec. 9 northward to the John Prout well in the eastern part of the SE. $\frac{1}{4}$ SW. $\frac{1}{4}$ sec. 4. Be-

tween these two bounding ridges is a broad, flat area diversified by a few small hollows or synclines.

The broadest portion of the eastern anticline lies just west of McFarland School in the NE. corner of sec. 9 and the SE. corner of sec. 4. From here the anticline narrows rapidly toward the north, and at the J. Biehl well in the NE. $\frac{1}{4}$ SE. $\frac{1}{4}$ sec. 4 it is a sharp ridge. To the south the crest becomes narrow in the SE. $\frac{1}{4}$ NE. $\frac{1}{4}$ sec. 9, but farther south on the Caroline Smith farm, it widens into a small, elongate dome which for convenience may be designated the Caroline Smith dome.

The secondary anticline in the western part of the field is not well developed, though it gains sufficient prominence to appear upon the contour map and to affect materially the production of the wells located in its vicinity. Its top is about 25 feet lower than that of the eastern anticline. As already indicated, it marks the western limit of the elevated area. On its western flanks the beds dip steeply to the west.

In the southern part of the field there appears to be a minor ridge extending through the W. H. Armstrong farm and northward to include wells No. 7 and No. 8 on the McMillen farm. This elevated area is separated from the Caroline Smith dome by a shallow trough or syncline (see Plate V).

Another structural feature which deserves mention is the small terrace in the western part of the SE. $\frac{1}{4}$ sec. 4 upon which are located the four wells Wm. Wolf, H. Jones No. 1, and Elisha Litherland Nos. 1 and 2. This is a relatively inconspicuous feature, yet its effect is very evident in the production records of the wells located upon it.

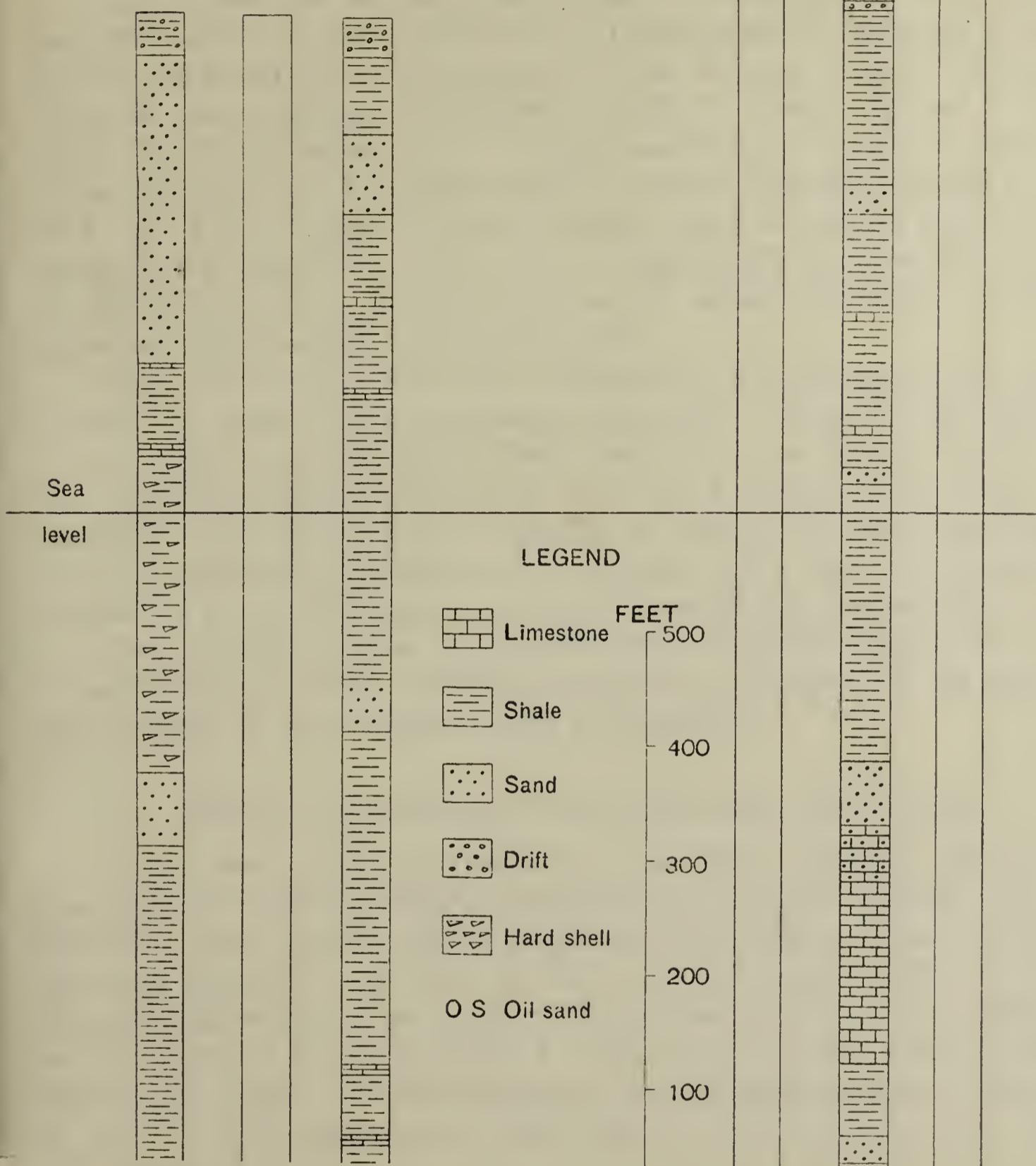
PRODUCTION RECORDS IN RELATION TO STRUCTURE

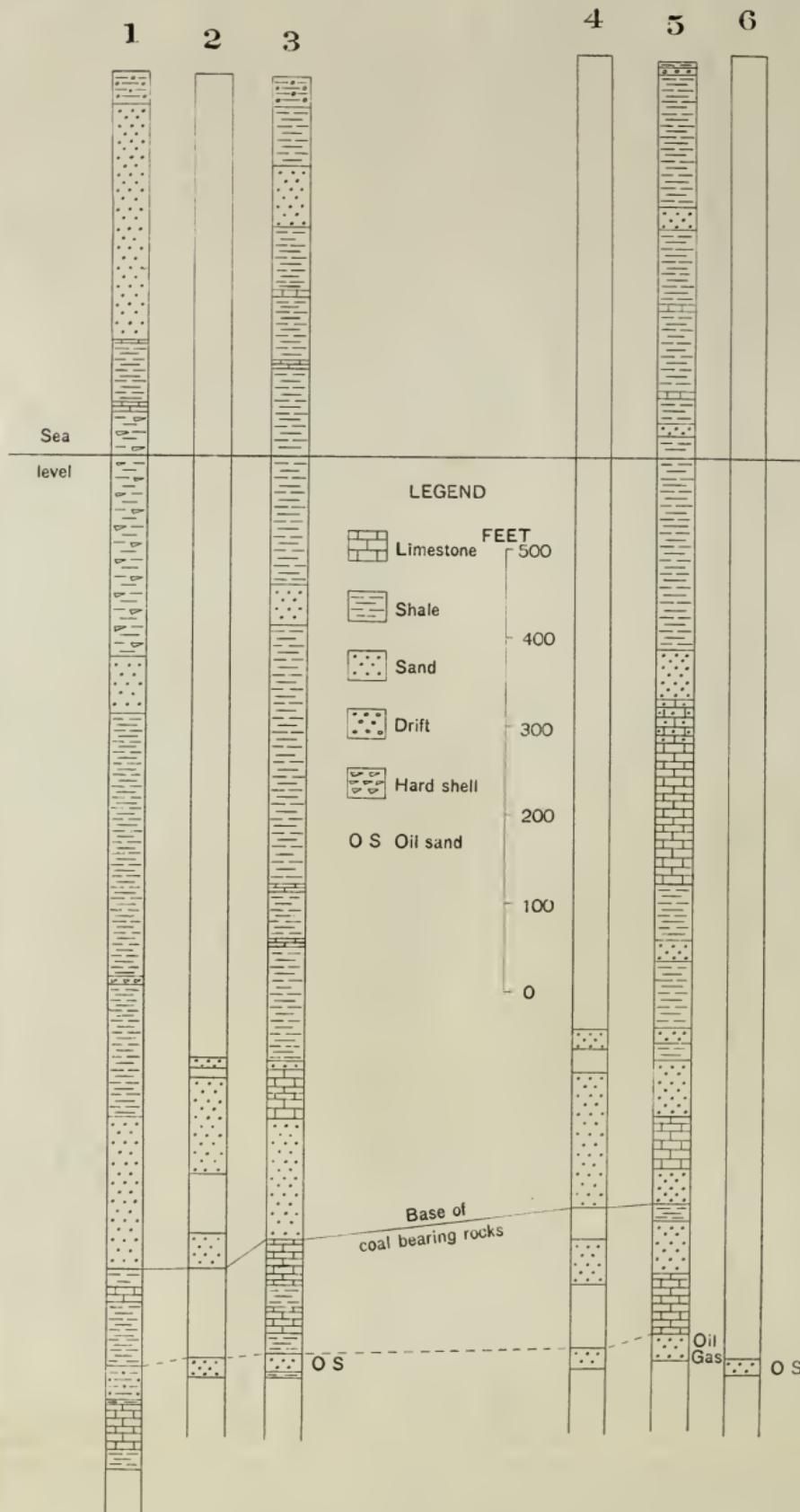
The accompanying map (Plate VI) shows the initial and the present (July 1, 1914) production of each of the wells from which data could be secured. A study of these records in relation to structure yields strong confirmation of the theory that oil tends to accumulate at or near the crests of anticlines or domes or on local flattenings (terraces) in dipping rocks. From the map it is evident that only the wells situated upon the crest or high on the sides of the elevated tract were productive. The most conspicuous features brought out by this map are: (1) the uniformly high initial yield of the wells situated upon the higher parts of the main anticline and of the Caroline Smith dome; (2) the good yields of the four wells situated upon the Jones-Prout-Litherland terrace;¹ (3) the relatively high yields of the wells (Edwin Smith, Nos. 1 and 3, and H. Mulinax No. 1) situated on the crest of the western anticline; and (4) the relatively low yields of wells situated on local depressions.

¹A letter dated Dec. 3, 1914 states that wells J. B. Litherland Nos. 1 and 2 have declined considerably within the past two months.

1 2 3

4 5 6





- 1 Della V Wright No.2 Wabash Twp., Sec.9, T.1 N.R.12 W.
- 2 Della V.Wright No.1 Wabash Twp., Sec.9, T.1 N.R.12 W.
- 3 McMillen Farm No.6 S.E.1/4 N.E.1/4, Sec.9, T.1 N., R.12 W.
- 4 Caroline Smith No.2 Wabash Twp., Sec.9, T.1 N., R.12 W.
- 5 Caroline Smith No.1 Wabash Twp., Sec.9, T.1 N., R.12 W.
- 6 H.Buchanan No.1 N.W.Cor., S.W.1/4, Sec.10, Wabash Twp.

East-west cross-section through Allendale field showing position of oil sand

The thick limestones shown in the lower part of the coal-bearing rocks in 3 and 5 were probably incorrectly reported by the driller. They should probably be shown as sandstone or sandy shale.

In some wells the production reported is much smaller than would be expected from the structure; for instance, Caroline Smith No. 1 started with 480 barrels per day; whereas No. 11, apparently as favorably located, gave an initial output of only 65 barrels. The decrease is better understood when the date of drilling is considered. Well No. 1 was completed in Sept. 1912; No. 11 in August, 1913. In the meantime the pressure upon the oil in the pool must have been notably decreased by the drawing off of oil to No. 1 and several other wells nearby, most of them at lower levels. Similarly, Ed. Smith Nos. 1 and 4, the one apparently as favorably situated as the other, show a marked difference in initial production, and here again the earlier well gave the higher yield.

There can be little doubt that variations in the porosity of the sands account for some of the discrepancies observed. Certain of the records of the wells in the Caroline Smith dome seem to show that the oil sand was not saturated entirely to the top. A study of this feature in connection with the structure leads to the belief that the phenomenon is to be explained by variations in the porosity of the sand, the top portion in some of the wells being too compact to permit the accumulation of oil.

Gas in small quantities was reported from Caroline Smith Nos. 1, 2, 4, and 8, but no definite relation between the occurrence of the gas and the structure or other features could be discerned.

AREAS FAVORABLE FOR FURTHER DRILLING

On the map (Plate VI) the areas in which the structure seems most favorable for further drilling are indicated by cross-line shading. For the most part these areas lie within the limits of the field as already outlined. The area indicated in the NE. $\frac{1}{4}$ NW. $\frac{1}{4}$ sec. 9 seems worthy of testing by a hole placed about one location south of the road and a short distance west of north of H. Mulinax No. 1. One or more wells in the McMillen tract ought to pay. A considerable area of favorable territory is included in the Ed Smith and Jacob Smith farms. This territory is not likely to furnish high yields, but a moderate production may be expected. Another area which seems favorable includes parts of the Jo. Jordan, Jacob Smith and Adam Biehl farms.

POSSIBILITY OF FURTHER DEVELOPMENT BY DEEPER DRILLING

Considering the success of the deep wells in the McClosky sand in the vicinity of St. Francisville, it would seem worth while to test this sand in the Allendale field. Thus far no wells within the producing area of the field have gone sufficiently deep to reach the McClosky. Two wells—the John H. Schafer and the C. F. Adams—have penetrated to a depth

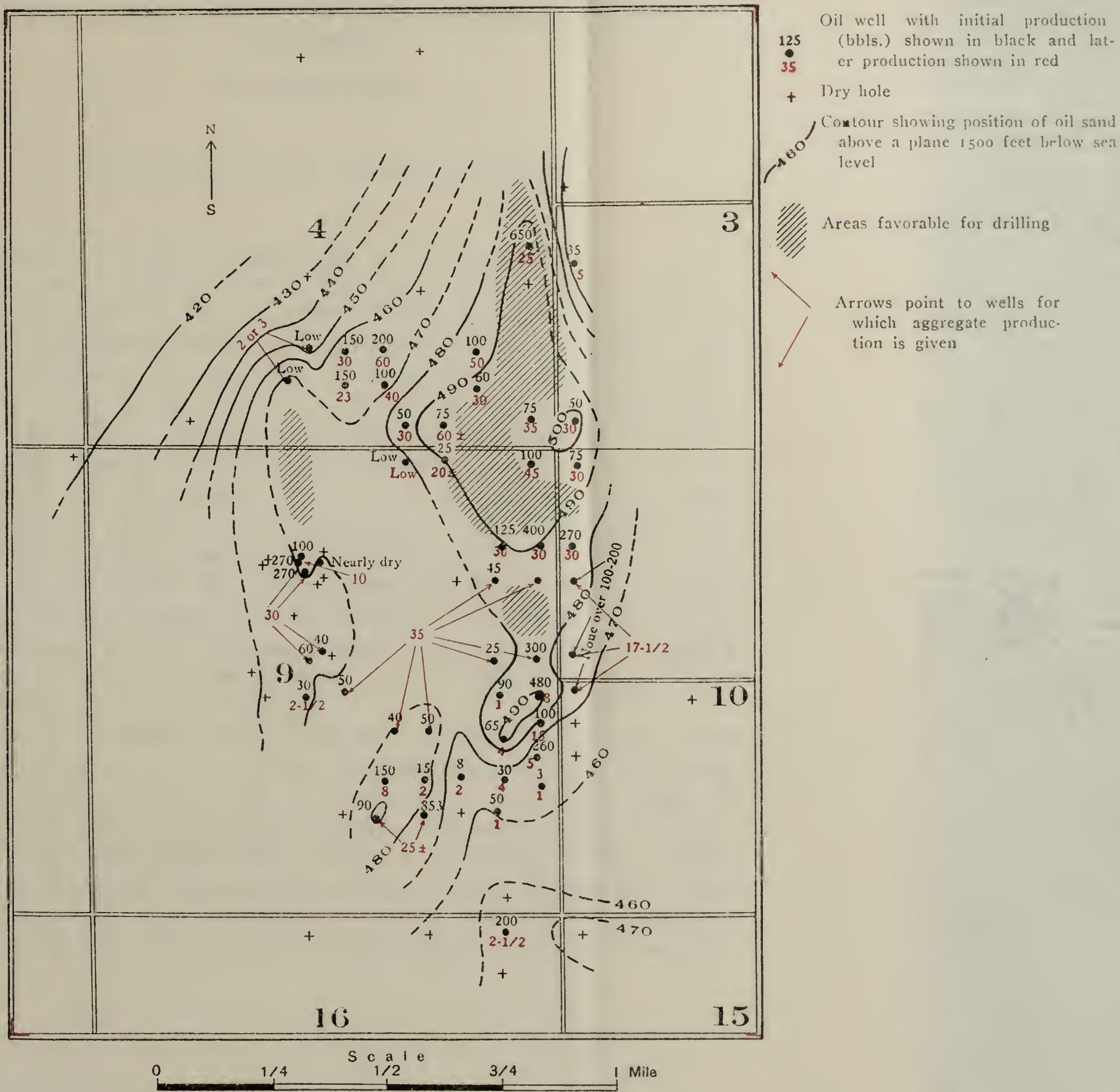
somewhat over 2000 feet, but appear not to have reached the McClosky. Besides, these wells are not located upon the higher structures, so that, even had they gone deeper, it is doubtful if they would have been successful.

The Chester is thicker in this region than in the Lawrence County field; consequently, the depth to the McClosky is greater. It is thought that the McClosky should be reached at about 600 feet below the Biehl sand, which would mean for most of the field a depth of 2100 to 2200 feet below the surface, though it is possible that the depth might be slightly greater.

Should a successful well be drilled to the McClosky sand, further development should proceed cautiously upon the higher parts of the structure as indicated on the map (Plate VI). There are no indications that wildcatting outside this area would meet with success.

ILLINOIS STATE GEOLOGICAL SURVEY

BULLETIN NO. 31, PLATE VI



Map showing initial and later production of Allendale wells

ANTICLINAL STRUCTURE IN RANDOLPH COUNTY

By Stuart Weller

(In cooperation with the U. S. Geological Survey)

The association of petroleum with anticlinal structure in the rock strata has been so well established that the recognition of such folds is of prime importance to the oil driller. During the detailed mapping of the Chester quadrangle comprising a portion of Randolph County a small anticline which may be productive of oil if properly drilled has been recognized. This anticline is just north of Bremen about eight miles northeast of Chester. The axis of the anticline, as located on the accompanying map, extends N. 70° E. and very nearly intersects the corner between secs. 21, 22, 27, and 28, T. 6 S., R. 6 W. On its northern limb the rocks dip at angles from 7 to 10 degrees; whereas the dip of the southern limb is about 2 degrees. The folding of the rock has not been detected west of Little Marys River and the dipping strata are best exposed in the east tributaries of this stream. The extension of the fold to the northeast has not been determined because the detailed mapping has not been extended in that direction, but it is altogether probable that the structure becomes more pronounced.

The rock formations involved in the Bremen anticline are of the Chester group and the base of the Pennsylvanian series. The entire thickness of the Chester group, as developed in Randolph County, is present in this area. In the eastern Illinois field much of the oil is produced from the sands in the lower portion of the Chester group, probably the Renault formation, which would be penetrated at Bremen at a depth of 500 to 600 feet. The comparatively shallow depth of the possible oil sands in the Bremen anticline makes prospecting in the territory desirable.

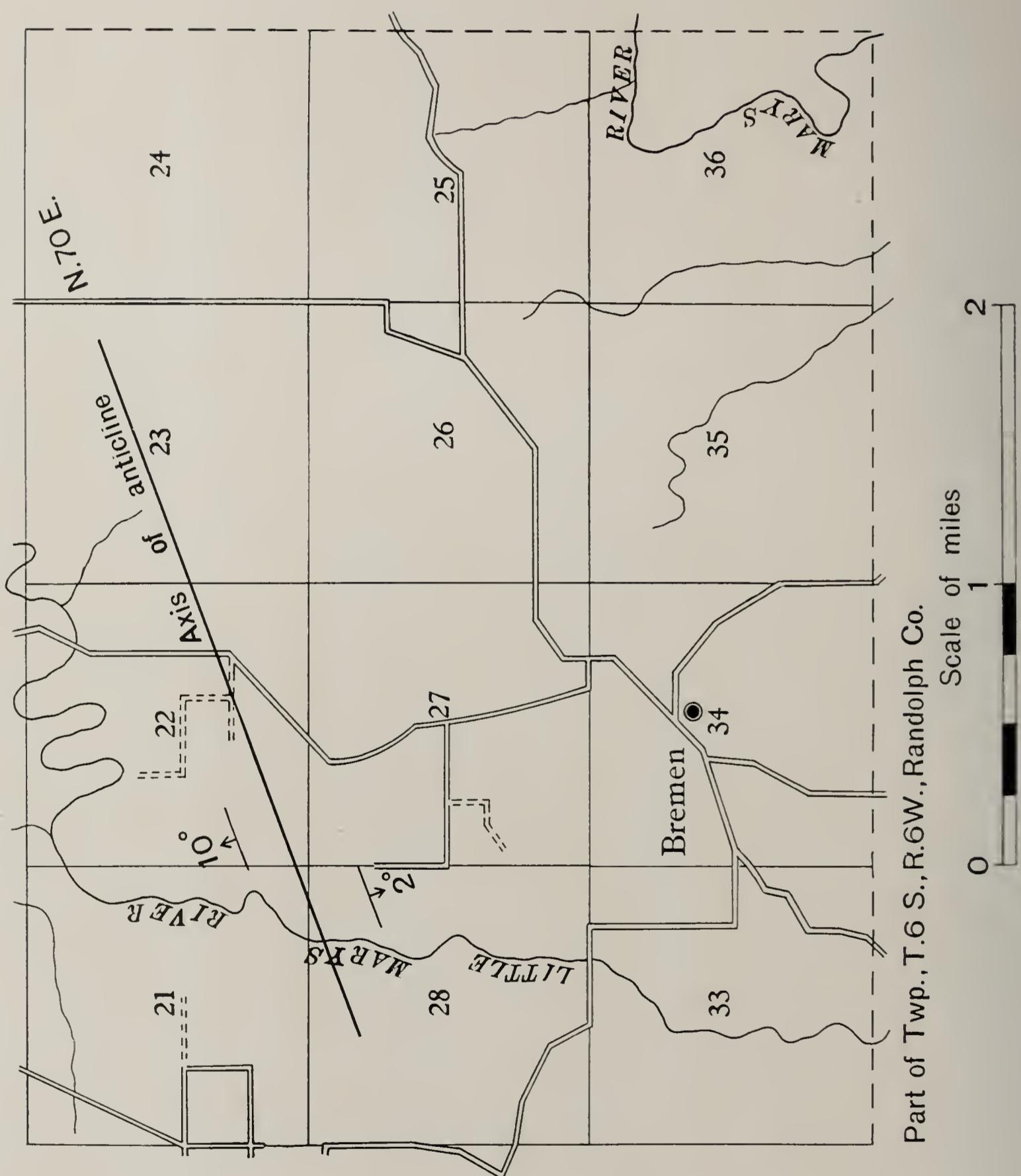


FIG. 16. Map showing location of Bremen anticline.

OIL AND GAS IN THE GILLESPIE AND MT. OLIVE QUADRANGLES, ILLINOIS

By Wallace Lee

(U. S. Geological Survey in cooperation with the Illinois State Geological Survey)

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INTRODUCTION

ACKNOWLEDGMENTS

The area of which this report treats lies in Macoupin, Montgomery, and Bond counties and was included in the region recently discussed by R. S. Blatchley¹. However, Mr. Blatchley's report was somewhat preliminary in nature. Since it was published, the work on which the present report is based was undertaken by the State Survey in cooperation with the United States Geological Survey under considerably more advantageous circumstances. Topographic maps prepared under the same cooperative agreement made it possible to determine altitudes of the tops of wells much more accurately. A considerable number of new drill records have also been secured, and the rock outcrops have been examined, such data giving a much greater number of points than was available for the determination of the structure of the rocks at the time Bulletin 28 was written. The present report though having these advantages over previous work still lacks detail in parts of the area where neither outcrops nor well logs are available.

The writer wishes to acknowledge with thanks the assistance given by the Superior Coal Company in the persons of Messrs. John Reese and John Ross of Gillespie; by Mr. A. W. Crawford of Hillsboro, Mr. E. J. Hurd of Chicago, Messrs. David Davis and H. Hood of Litchfield, Mr. Frank Brown of Hillsboro and Messrs. E. A. Ibbetson and T. A. Rinaker of Carlinville, and many others to whose generous cooperation in allowing the use of private information and to whose public-spirited attitude toward the work, the writer owes to a considerable extent the value of this report.

AREA TREATED IN REPORT

The area examined comprises the Gillespie and Mt. Olive quadrangles mapped topographically by the United States Geological Survey in cooperation with the Illinois State Geological Survey, an area 27 miles from east to west and 17 miles from north to south. It includes the southeastern part of Macoupin County, the southwestern part of Montgomery, and a small area in the northwestern corner of Bond County. The area extends from a point two miles south of Carlinville to Staunton and Sorento on the south, and from Hillsboro on the eastern margin to Plainview and Bunker Hill near the western edge. The district includes also the towns of Litchfield, Mt. Olive, Gillespie, and Benld and the villages of Dorchester, Hornsby, Butler, Walshville, and Panama.

¹Blatchley, R. S., Oil and gas in Bond, Macoupin, and Montgomery counties: Ill. Geol. Survey, Bull. 28, 1914.

DRAINAGE AND TOPOGRAPHY

Macoupin Creek, flowing in a general westerly direction into Illinois River, drains the northwestern corner of the area. Shoal Creek with its tributaries drains the eastern half of the district and flows south into Kaskaskia River. The southwestern quarter is drained by the head waters of Wood River and Cahokia Creek, which flow southwest and empty directly into Mississippi River. The forked divide between these creeks is a broad, flat, undissected prairie rising imperceptibly toward the northeast. Near Bunker Hill the altitude is 660 feet above sea level, whereas 20 miles distant at Litchfield, it is only 20 feet greater. East of Shoal Creek the prairie surface is broken by morainic hills left by a continental glacier. Several of these hills rise more than 75 feet above the general level. The valleys are incised in the flat prairie surface and have rather steep confining slopes. The major streams have cut to a depth of 75 to 85 feet below the upland prairie level.

STRATIGRAPHY

The rocks of southern Illinois consist of nearly horizontal layers of shale, sandstone, limestone, and coal which will be described in order from the lowest and oldest to the highest and youngest. In southern Illinois the older rocks do not outcrop at the surface and are known only from drill holes and from outcrops in adjoining states. They form a series of sandstone, limestone, and shale beds resting on an irregular, and exceedingly ancient surface composed of granite and allied rocks. The rocks above this old surface are more or less perfectly known in adjoining regions where they are exposed and where they have been examined and described. Their thickness and their lithologic character, however, vary from place to place, so that whereas their presence may often be predicted where they are not exposed, the exact thickness and relation of the beds to each other can not be known with certainty at places far from the outcrops in anticipation of drilling.

CAMBRIAN AND ORDOVICIAN ROCKS

The basal granitic rocks which are pre-Cambrian in age have never been penetrated in central Illinois. The deepest well in the area, the Mark Flitz well, drilled by the Producers Oil Company on the flood plain of Long Branch in sec. 7, T. 8 N., R. 5 W., is 3770 feet deep. At a depth of 2685 feet the boring passed into a limestone which is thought to be the top of a series of Cambrian and Ordovician rocks which overlie the granite and underlie the St. Peter sandstone. Only 85 feet of the limestone series was penetrated in this well, but in southwestern Missouri where the rocks outcrop at the surface the rocks underlying the St. Peter sandstone consist of 2100 feet or more of magnesian limestone containing sev-

eral thin sandstone beds, a thick sandstone bed of irregular development usually resting on the rough surface of the granite rocks beneath the magnesian limestone series.

The St. Peter sandstone², known widely as a source of artesian water, was penterated at a depth of 2570 feet and is 115 feet thick; but here, as well as at other points in the southern part of the State, the water is very salty and quite unfit for domestic use. The Kimmswick and Plattin limestones overlie the St. Peter. They have a combined thickness of 808 feet and include 195 feet of shale 115 feet above the base and a 35-foot bed of sandstone 48 feet below the top. The Maquoketa shale, which overlies the Kimmswick and Plattin limestones, is 120 feet thick with 12 feet of limestone 35 feet above the base.

SILURIAN AND DEVONIAN ROCKS

The Silurian system is thought by T. E. Savage to be represented by 24 feet of limestone referred by him to what he calls the Alexandrian series, in which he includes the Cape Girardeau limestone. The Devonian is apparently absent, though the overlying shales may include deposits of this age.

MISSISSIPPIAN SERIES

The Mississippian series of the Carboniferous system as represented in the Mark Flitz well consists of 348 feet of shale at the base, which is mostly Kinderhook, though possibly some Devonian strata are included; and of 530 feet of limestone of the Osage and Meramec groups at the top. In this well 105 feet of sand is reported at the base of this limestone series. Sand is not known elsewhere at this horizon and the accuracy of the log is questioned. This is overlain by 125 feet of limestone succeeded by 15 feet of sandstone and 285 feet of limestone representing the Burlington, Keokuk, Warsaw, Spergen, and St. Louis limestones of the Osage and Meramec groups. The top of the limestone series is believed to be the St. Louis limestone.

The Chester group, which contains the oil-bearing sands of the Carlyle field, if present at all at this point has very slight development, and the beds are not distinguishable in the log. At the close of Mississippian time the rocks appear to have suffered some deformation and very considerable erosion, so that the surface was underlain at some points by beds which had elsewhere been cut away. Five or six miles south of the Mark Flitz well some of the Chester beds appear to have been preserved. Fifty to seventy-five feet of sandy beds, beginning with red shale is reported here in several wells; but in a deep well north of Nokomis, 16 miles northeast of

²The log of this well was interpreted by T. E. Savage and R. S. Blatchley in Bull. 28, Ill. Geol. Survey, pp. 20, 21.

Hillsboro, over 250 feet of Chester beds, consisting chiefly of green, white, gray, and red shales was penetrated.

PENNSYLVANIAN SERIES

GENERAL STATEMENT

The Pennsylvanian series has been divided into three formations, the Pottsville extending from the base of the coal-bearing rocks to the base of the Murphysboro (No. 2) coal; the Carbondale comprising all strata from the base of the Murphysboro (No. 2) coal to the top of the Herrin (No. 6) coal; and the McLeansboro including all beds from the Herrin (No. 6) coal to the top of the "Coal Measures."

The Pottsville rests on the old eroded surface of the Mississippian rocks and is overlain conformably by the Carbondale formation, which is composed chiefly of shale, sandy shale, sandstone, and several widely worked and valuable coal beds. In fact, the Carbondale formation contains most of the coal beds mined in Illinois, the coals of the other two formations rarely being found sufficiently thick for profitable exploitation. The Carbondale formation is overlain by the McLeansboro formation, composed of shales, sandy shales, thin coal beds, and several conspicuous limestone members.

The identity of the Murphysboro (No. 2) coal in the Gillespie-Mt. Olive quadrangles has been determined by faunal and stratigraphic evidence. Fossil plants associated with the coal as determined by David White³ indicate that the coal worked in the Litchfield mine is not far below the top of the Pottsville formation. Comparison of the logs of wells in Jackson County to the south and La Salle County to the north, where the Murphysboro (No. 2) coal has been worked, with the logs of wells in this area and at intervening points, indicates the fifth of a series of six coal horizons below the top of the Carbondale formation as that of the Murphysboro or No. 2 coal. This is the next coal above that worked in the recently abandoned Litchfield shaft and the stratigraphic correlation is therefore consistent with the paleontologic evidence.

The Herrin or No. 6 coal, whose top is the dividing line between the McLeansboro and Carbondale formations, is a thick coal underlying a persistent limestone horizon in the lower McLeansboro formation known for the presence in it of a small fossil, *Girtyina ventricosa*. This fossil has been referred to in earlier reports by a number of names chief of which perhaps is *Fusulina sccalica*. In size and shape it is not unlike a grain of wheat. This coal is the most conspicuous bed in the entire Penn-

³The lenticular coals known as Nos. 3 and 4 in this report are valuable as correlation beds in the district under consideration and for convenience they are designated by number. These numbers are not intended to apply to coals in somewhat similar positions in the geologic section throughout the State (Editor).

³White, David, Paleo-botanical work in Illinois in 1908: Ill. Geol. Survey, Bull. 14, p. 294, 1908.

sylvanian series in this part of the State and is the only coal bed at present worked in this area.

POTTSVILLE FORMATION

The Pottsville formation, by reason of the irregular surface on which it was deposited, is variable in thickness. Near Hillsboro it is 125 feet thick, near Litchfield 150 feet, and south of Carlinville 100 feet. In a drilled well three miles north of Plainview only 75 feet of Pottsville beds appear to be present and it seems probable in consequence that a low hill was present in this vicinity on the old surface, at the close of Mississippian time.

Although sandstone and sandy shales have been reported at every horizon between the top of the Mississippian rocks and the Herrin (No. 6) coal, it may be said that the horizon of the Murphysboro (No. 2) coal marks a change in general character, sandstone beds being much more common below than above. In the Pottsville the strata consist chiefly of alternating sand and sandy shale beds in which the sand predominates. As reported in the logs there is apparently no continuity in any of the sands, and the conclusion seems to be justified that they are broken and interrupted. They seem to be either distinct lens-shaped bodies of limited extent or merely represent localities where less clay was deposited by the shifting currents than elsewhere. Certain beds have a local continuity, and certain parts of the series of beds are more sandy than others, but there do not appear to be any widely spread sandstone beds. Particular interest attaches to the sandstone of this formation since the oil and gas of the Carlinville and Litchfield pools comes from lenticular sandstone bodies near its top and below the base of the Carbondale.

Only one coal bed is known to occur in the Pottsville of this area. It is the lowest of a series of six coals below the top of the Carbondale formation. At the Litchfield mine it lies 250 feet below the top of the Herrin (No. 6) coal and 40 feet below the base of the Murphysboro (No. 2) coal. Stratigraphically it corresponds to and may be equivalent of coal No. 1 of Worthen.

CARBONDALE FORMATION

The Carbondale was deposited above the Pottsville apparently without any greater interruption to sedimentation than is indicated by the oscillating conditions recorded in the change in sediments within the formations themselves. The formation is much more uniform in thickness than the Pottsville, since the accumulation of Carbondale deposits began on an already leveled surface. The variation in thickness is only between 205 and 220 feet. It consists chiefly of shales, sandy shales, sandstones, several valuable coal beds, and a few thin limestones.

As in many other localities the basal member of the formation, the Murphysboro (No. 2) coal, is in most places bifurcated and consists of two thin coal beds. These beds have not been reported in all the logs of wells bored to the depth of this coal, but beds of black shale thought to be representative of it are present in some localities.

About 75 feet above the base of the Carbondale and about 135 feet below the top of the Herrin (No. 6) coal lies a group of coal beds occupying the stratigraphic position of Worthen's coal No. 3. The two principal beds are separated in most places by 5 to 8 feet of shale and limestone, the latter being from 1 to 4 feet thick. The thickest of these beds is probably the coal formerly worked in the old Litchfield mine east of town where, however, only one coal bed 4 feet thick was reported without any associated limestone. In many of the logs a thin limestone layer, which, however, may be concretionary, is reported just above the coal; in some a thin layer is also reported below the lower bench. In a few of the logs a third bed of coal is present as in the Litchfield shaft north of town, where three beds of coal are separated by two thin limestones and associated shale.

This coal bed, or perhaps group of coal beds, and associated limestones are present in logs of wells in Marshall, Livingston, Macon, Scott, Cass, Macoupin, and Montgomery counties and may be regarded a valuable datum plane in this part of Illinois when used in connection with other well-known strata. The following section of this group of coals from the Litchfield shaft is typical.

Section of coal (Worthen No. 3) and associated strata at Litchfield shaft

	Thickness
	Ft. In.
Sandy shale .....	.. ..
Black shale.....	1 11
Coal	1 10
Shale	2 3
Limestone	3 ..
Shale	1 2
Coal, slaty .....	.. 10
Coal	2 7
Shale	1 5
Limestone	1 ..
Shale, dark	2 6
Coal .....	.. 9
Shale and fire clay.....	.. ..

19 3

The absence of the highest or lowest coal bed would make an apparent reversal in the order of the limestone reported so frequently at this horizon, thus giving the appearance of a limestone above or below the coal. The limestone is not an associate of this bed to the southeast, though it appears

to be present to the southwest in Madison and La Salle counties, where probably for the reason suggested above limestone appears to lie above the coal.

Approximately 40 to 60 feet above No. 3 coal group is a bed which appears at the stratigraphic position of Worthen's coal No. 4. It is 75 to 100 feet below the top of the Herrin (No. 6) coal; and though it has been frequently reported to be of workable thickness in the drill records, it has never been mined to any extent, due probably to its thinness in the two shafts which have been sunk to the deeper coal beds.

The Springfield (No. 5) coal lies from 40 to 50 feet below the Herrin (No. 6) coal. It has a thickness of only 2 or 3 feet and usually less, and is frequently reported as a very thin sheet of only a few inches. It appears not to be present at many localities for it is not reported in many carefully kept logs.

The Herrin (No. 6) coal is the principal bed of the region and the only one mined in the district at present. It has a thickness of 5 to 8 feet throughout the greater part of the area, but in a strip 5 or 6 miles wide extending north and slightly east of south from Litchfield the coal is thin or entirely absent. In the eastern part of the field, particularly near Hillsboro, the coal appears to have been cut away after deposition, for it is absent in channel-like areas. An important advantage in mining the seam is the prevailing limestone roof. Locally, however, the limestone has been replaced by shale, and this has caused the abandonment near Mt. Olive of otherwise valuable bodies of coal. Throughout a considerable part of T. 9 N., R. 6 W., and locally in the northern part of T. 8 N., R. 6 W. and T. 8 N., R. 5 W. this condition exists. The position of the Pottsville and Carbondale coals is typically shown in the following log of a well located in the northeast quarter of sec. 29, T. 9 N., R. 5 W.

Log of well, sec. 29, T. 9 N., R. 5 W.

Description of strata	Thickness		Depth	
	Ft.	In.	Ft.	In.
Surface	15	..	15	..
Sand	1	..	16	..
Hardpan	29	..	45	..
McLeansboro formation				
Clay, sandy, blue.	18	..	63	..
Limestone . . . . .	..	10	63	10
Clay	43	2	107	..
Sand, green	13	..	120	..
Gravel	3	..	123	..
Limestone, broken.	12	..	135	..
Shale, sandy.	2	..	137	..
Slate, black.	1	..	138	..
Shale, sandy	45	..	183	..
Limestone, dirty	1	..	184	..

Description of strata	Thickness		Depth	
	Ft.	In.	Ft.	In.
Slate, black	1	7	185	7
Limestone, dirty	1	5	187	..
Coal, slaty .....	..	4	187	4
Shale, gray	6	8	194	..
Limestone with shale bands.....	5	..	199	..
Shale, sandy	24	..	223	..
Limestone	5	..	228	..
Sandstone	11	..	239	..
Shale, sandy	28	6	267	6
Shale, sandy	22	6	290	..
Sandstone	28	..	318	..
Shale	64	..	382	..
Limestone	5	..	387	..
Shale, sandy	13	..	400	..
Limestone	3	..	403	..
Shale	53	5	456	5
Carbondale formation				
Coal	1	1	457	6
Shale.....	1	1	458	7
Coal	1	5	460	..
Fire clay	1	..	461	..
Shale, blue	2	..	463	..
Conglomerate	3	..	466	..
Shale, hard gray.....	16	..	482	..
Slate, black	1	6	483	6
Coal, No. 5.....	1	1	484	7
Fire clay	2	5	487	..
Sandstone	46	2	533	2
Coal	2	4	535	6
Shale.....	..	4	535	10
Coal .....	..	8	536	6
Shale	2	6	539	..
Sandstone, shale partings.....	17	..	556	..
Shale, dark sandy.....	34	..	590	..
Shale, black	1	11	591	11
Coal	1	10	593	9
Shale.....	2	3	596	..
Limestone	3	..	599	..
Shale, soft	1	2	600	2
Coal, slaty .....	..	10	601	..
Coal	2	7	603	7
Shale.....	1	5	605	..
Limestone	1	..	606	..
Shale, dark	2	6	608	6
Coal .....	..	9	609	3
Shale, soft	4	3	613	6
Fire clay	9	6	623	..
Shale, sandy	16	..	639	..
Sandstone	5	..	644	..

Description of strata	Thickness		Depth	
	Ft.	In.	Ft.	In.
Slate, black	4	2	648	2
Coal .....	..	9	648	11
Shale.....} No. 2 {	12	4	661	3
Coal .....	..	10	662	1
Pottsville formation				
Shale, sandy	14	11	667	..
Sandstone, shaly	10	..	687	..
Shale, sandy, dark	14	..	701	..
Limestone, broken	2	..	703	..
Coal, No. 1.....	4	10	707	10
Fire clay, hard.....	6	2	714	..
Shale, dark	3	..	717	..
Sandstone, shale parting.....	14	..	731	..
Limestone, shale parting	3	..	734	..
Shale, dark sandy bands.....	9	..	743	..
Sandstone, hard	2	..	745	..
Shale, sandy	22	..	767	..
Sandstone	26	..	793	..
Shale, blue	10	..	803	..
Sandstone	8	..	811	..

The sandstones of the Carbondale formation, like those of the Pottsville, are irregular and discontinuous in character. The Vergennes sandstone member, so conspicuous a feature to the southeast in the Murphysboro-Herrin district, does not appear to be present in the Gillespie and Mt. Olive quadrangles. The interval between the Murphysboro (No. 2) coal and coal No. 3 is on the whole not sandy. It is true that in one or two logs a sandstone bed 5 to 8 feet thick is reported, and in some of the logs the entire interval is said to be sandy shale. The latter description however, appears in the less reliable logs and in any case is an exception.

Between the horizon of coal No. 3 and the Herrin (No. 6) coal the greatest diversity and irregularity of deposition of the sands exists. In the vicinity of Carlinville this part of the section is predominantly shaly though sand is not uncommon in the central portions. Near Litchfield, however, this part of the section is predominately sandy, though shale is also present.

Between the Herrin (No. 6) coal and the Springfield (No. 5) coal there is locally some limestone of variable thickness, and in some logs a few feet of limestone is reported immediately below the Springfield (No. 5) seam, though generally neither of these beds is present.

MCLEANSBORO FORMATION

The beds lying above the Herrin (No. 6) coal in this region belong to the McLeansboro formation. They consist of a series of shales and sandy shales, very subordinate sandstones, thin coal seams, and several conspicuous limestone beds which outcrop. The maximum thickness is in

the old abandoned Litchfield mine east of the town, where 380 feet of measured strata lie above the Herrin (No. 6) coal. Because of erosion of the upper part the formation thins westward so that the Herrin (No. 6) coal at the western edge of the area is overlain by less than 200 feet of combined McLeansboro rocks and glacial deposits. In this area the rocks of this part of the section are well known from prospect holes bored to the Herrin (No. 6) coal.

The most conspicuous surface features of the McLeansboro formation are the outcropping limestone members. Two of these are particularly conspicuous and are practically the only outcropping beds which can be readily identified. The lower of these beds, which had been named the Carlinville limestone from its exposures near that town, was in 1907 correlated by Jon A. Udden⁴ with the Shoal Creek limestone which outcrops on that stream near Breese. It appears clear, however, from outcrops in the head of Cahokia Creek between Gillespie and Staunton that there are two limestone beds the upper of which is the Shoal Creek, the lower the Carlinville member. A large number of drill holes in the vicinity and southward toward Breese corroborate this conclusion, and the members themselves exhibit distinctly different lithologic characteristics, at least in the area under question where both are present.

The base of the Shoal Creek limestone is about 75 feet above the Carlinville and from 275 to 325 feet above the Herrin (No. 6) coal, but toward the south this interval increases, being 350 feet at the Future mine at Breese. It is conspicuously exposed near shaft No. 3 of the Superior Coal Company and at other points in the vicinity of Gillespie, on Shoal Creek west of Litchfield, on Lake Fork and on Shoal Creek near Sorento, and elsewhere. By reason of the glaciation the top of the bed seldom appears in drilled wells or in exposures since the overlying soft shales and the upper part of the limestone seem to have been generally trimmed off by the moving ice sheet. Where not eroded it has a thickness of 12 to 25 feet, but it is not homogeneous like the Carlinville member in that it consists of a series of more or less argillaceous limestone layers. In certain localities the top, bottom, or middle is replaced by limy shale. Near Litchfield it appears to be split into two parts, the lower separated from the upper by 15 to 30 feet of shale, but it is possible that the lower part represents a local bed underlying the true Shoal Creek. The face of weathered exposures presents a ragged appearance due to fine conchoidal jointing of the thin beds.

The Carlinville limestone lies from 200 to 225 feet above the Herrin (No. 6) coal but this interval fluctuates, and at the eastern margin of the field where the logs show the bed thin and irregular, the interval is thought to diminish to 175 feet. Where best developed the bed has a thick-

⁴Udden, Jon A., Notes on the Shoal Creek Limestone: Ill. Geol. Survey Bull. 8, p. 118, 1907.

ness of 6 to 7 feet, and is tough, gray, dense, and much more homogeneous in character than the Shoal Creek member. The Carlinville is also less argillaceous and may be distinguished from the Shoal Creek by its smoother grain and its method of weathering, the Carlinville breaking into regular smooth-sided chips, whereas weathered outcrops of the Shoal Creek member are littered with ragged chips and plates. To the south toward the Breese and Belleville quadrangles the Carlinville member becomes thin and irregular and can not be positively identified in the logs. It is possible that it dies out to the south and is merely a lentil. The "top" limestone mentioned by Udden and Shaw⁵ in a description of the Belleville-Breese area may be its equivalent, but this bed is only 100 to 130 feet above the Herrin (No. 6) coal and probably represents a similar limestone lentil lower in the section. It seems more plausible to regard the "top" limestone therefore the equivalent of a sporadic limestone which is not uncommonly reported in the logs as lying 150 to 175 feet above the Herrin (No. 6) coal in the western part of the area, though there is nothing save the interval to justify the correlation.

Intermediate between the Carlinville and Shoal Creek members and 30 to 50 feet below the Shoal Creek member, another limestone bed is exposed at a number of localities south and west of Gillespie, but this bed does not appear to be continuous. It is in most places only 2 to 3 feet thick, but its close association with a continuous, black shale band or thin coal bed is sufficiently common to suggest that it occupies a definite position in the section, and that it may prove to be better developed in adjoining areas.

The limestone bed outcropping in the railroad cut east of Plainview which Worthen regarded as the Carlinville is believed to represent a local thick limestone bed mentioned above which is somewhat lower in the section and is shown by logs in this part of the state to lie about 150 feet above the Herrin (No. 6) coal.

Most persistent of all, in the well records of this part of the section is the limestone series overlying the Herrin (No. 6) coal. It is in most places from 20 to 30 feet thick, but in many localities the continuity of limestone deposition was broken by shale deposits, the limestone alternating with shale beds and forming a distinct, though heterogeneous, group. This limestone bed, which is one of the most useful criteria for identifying the Herrin (No. 6) coal by reason of its persistence and the presence in it of a small, distinctive fossil, is absent, however, in most of the logs in a strip from northwest to southeast through the central part of the area.

Another persistent member is a bed of red, or brownish, clay shown in the above section. It is usually reported from 40 to 60 feet above the coal. This bed, although having a variable position, lies above the first thin coal bed above the Herrin (No. 6) coal. It is widely recorded in

⁵Udden, J. A., and Shaw, E. W., U. S. Geol. Survey, Geol. Atlas, Belleville-Breese folio (No. 195), p. 6, 1915.

logs, being present at least as far north as the Springfield area and reported in logs 20 miles south of the Gillespie-Mt. Olive quadrangle. It probably represents a period of elevation and erosion when the iron content of the exposed shales became oxidized.

Four thin coal members are persistent throughout the area and are usually reported in the logs. Their general position, as well as that of the limestones is well shown in the accompanying log.

Log of well in SW. part of T. 8 N., R. 5 W.

Description of strata	Thickness		Depth	
	Ft.	In.	Ft.	In.
Clay, yellow	4	..	4	..
Sand	6	..	10	..
Clay, yellow.....	25	..	35	..
Sand	7	..	42	..
Clay, blue.....	33	..	75	..
Sand and gravel.....	8	..	83	..
Shale, limy	13	..	96	..
<i>Limestone</i> , Shoal Creek.....	16	..	112	..
Shale, dark	37	..	149	..
Coal .....	..	3	149	3
Shale, clayey.....	..	9	150	..
Shale, black.....	3	..	153	..
Coal .....	..	3	153	3
Shale, clay.....	5	9	159	..
Shale, limy.....	2	..	161	..
<i>Limestone</i>	4	..	165	..
Shale, sandy	10	..	175	..
Shale, dark	15	..	190	..
<i>Limestone</i> , Carlinville	6	..	196	..
Shale, sandy.....	23	..	219	..
Shale, gray	20	..	239	..
Coal .....	..	6	239	6
Shale	2	6	242	..
Shale, limy	9	..	251	..
Shale, sandy	32	..	283	..
Shale, gray.....	48	..	331	..
Shale, dark blue.....	11	9	342	9
Coal .....	..	3	343	..
Shale, clay.....	6	..	349	..
Shale, dark	5	..	354	..
Shale, clay.....	2	..	356	..
<i>Shale</i> , red	8	..	364	..
Shale, limy	2	..	366	..
<i>Limestone</i>	6	..	372	..
Shale	4	..	376	..
Slate, blue.....	1	..	377	..
Coal	1	6	378	6
Shale, gray	9	6	388	..
<i>Limestone</i>	16	..	404	..

Description of strata	Thickness		Depth	
	Ft.	In.	Ft.	In.
Shale, dark	4	..	408	..
Coal, No. 6.....	8	9	416	9
Shale, clay.....	3	3	420	..

Sandstone beds have been reported in the well logs at all horizons of the McLeansboro, and though sandy shale is conspicuous above the red clay horizon, no sharply marked continuous sandstones or sandy horizons are present.

QUATERNARY DEPOSITS

Overlying the surface of the McLeansboro formation is a series of pebbly and sandy clay deposits called *drift* which varies in thickness from a few feet to 190 feet. These deposits were accumulated very much later than the "Coal Measures" and were deposited on them after they had been worn down by erosion to a surface considerably more broken and hilly than that which forms the surface today. This old surface was finally covered by a great continental ice sheet which swept down from the north bearing with it the debris worn from the rocks over which it plowed. After the melting of this ice the old valleys in this part of the State had been completely buried by the debris, and nearly the entire surface of the State was left with a surface such as that which today exists on the flat upland divides in this area. Since that time the drainage from this great flat area has developed valleys and cut deeply into the covering of glacial drift and in many localities into the rocks of the "Coal Measures" below.

Sticks, stumps, and buried soils found between the upper and lower parts of the glacial debris, clearly indicate that this part of Illinois, in common with areas farther north, was buried beneath at least two successive great ice sheets, and that a period long enough for the growth of forests and the accumulation of soil elapsed between the disappearance of the first ice sheet and the advance of the second. The hills in the vicinity of Hillsboro were probably built up at the edge of the second ice sheet during a pause in its retreat, the ice dropping its load at the edge of the glacier and leaving it behind when climatic conditions caused a melting of the ice.

STRUCTURE

STRUCTURE CONTOURS

The position of coal No. 6 above sea level is shown in Plates IX and X by means of red contour lines. Since the beds above and below the coal are approximately parallel to it, the contours show the general geological structure of all the beds. In order that the reader may understand and interpret the structure contour, he is requested to examine Plate X. The

prominent red lines represent the surface of coal No. 6 as it would appear if all the overlying beds were removed.

The reader is requested to imagine the surface of coal No. 6 to be flooded by a large body of water the surface of which lies 150 feet above the present sea level. The shore line would be represented by the 150-foot contour. If the level of the water were raised by 25-foot intervals the successive shore lines would be indicated by the corresponding contours. The upward folds or anticlines, as in the western part of Butler Grove Township, would extend out into the sea as long arms of land, whereas the downward folds or synclines such as the one north of Litchfield would be covered by bays and lagoons. If the water stood at the 250-foot contour line, the dome one mile southeast of Litchfield would be an island 50 feet above the sea.

It should be borne in mind that the contours show only the larger and more prominent features of the structure. In parts of the area where neither rock exposures nor drill holes are available the structure is indicated by broken lines, to show that their position has been determined by inference only. The workings of the coal mines show many fluctuations which the sparsely grouped drill holes fail to reveal.

These fluctuations of the coal usually shown on the floor of coal mines amount locally to 10 or 20 feet and more and have no apparent relation to the general structure. As there is no way of determining whether a drill hole has penetrated an anticlinal or synclinal phase of this subordinate warping, a certain amount of deviation from the actual structure is thus inevitably introduced in the structure contour map.

STRUCTURE OF THE GILLESPIE AND Mt. OLIVE QUADRANGLES

The rocks of the area have not suffered marked deformation. The strata have been warped into irregular and very low domes and shallow basins without any very definite order of arrangement. As shown in Plate IX the Herrin (No. 6) coal rises irregularly from an altitude of 150 feet in the southeast corner to over 400 feet near the western margin of the area, an increase of elevation of nearly 275 feet. In parts of the area the strata are practically flat, as in the area southeast of Mt. Olive, where the average dip is about four feet to the mile toward the east. The steepest dips occur north of Staunton, where for a distance of about one mile the beds dip eastward from 25 to 40 feet to the mile, and near Panama where, about the flanks of a ridge-like structural feature, for a distance of less than one half mile the dip is over 100 feet to the mile.

The chief structural features are: a trough which may be called the Shoal Creek syncline, extending from Panama nearly to Litchfield, and closely following the valley of Shoal Creek; a structural flat 6 to 8 miles wide extending from Walshville Township northwest into Honey Point Township; and a gently sloping surface rising from this flat to the west.

the last feature being greatly modified by subordinate warpings. A less distinct feature which strongly suggests a gentle anticline diagonally crosses these larger deformations and extends from sec. 4, T. 9 N., R. 4 W. southwesterly toward Litchfield and Mt. Olive. A sharp anticlinal ridge also projects from the west side of the Shoal Creek syncline and extends from a point north of Sorento to a point south of Panama, and around the flanks of this occur the steep slopes already mentioned. A structural basin which occurs north of Litchfield is very evident at the Litchfield mine and farther north. The horizon of the Herrin (No. 6) coal is here depressed nearly 50 feet below its general position. It is probable that this basin extends to the northward, possibly in continuation of the interrupted Shoal Creek syncline cut off by the diagonally trending anticline mentioned.

Domes occur in the Carlinville oil field; in the Litchfield oil field; 3 miles northwest of Staunton; 5 miles southwest of Litchfield; and it is probable that in an ill-defined area northwest of Butler the strata are higher than in the surrounding country. Another small area $3\frac{1}{2}$ miles north of Plainview is also doubtfully regarded as dome structure. These structures, which are of particular interest in prospecting for oil, will be described in greater detail.

LITCHFIELD OIL AND GAS FIELD

The first valuable deposit of oil found in the State was discovered at Litchfield by the Litchfield Coal Company in November, 1879.⁶ In an effort to find a lower coal seam sufficiently thick to be profitably mined, a hole was drilled in the bottom of the shaft which passed into oil-bearing sand at a depth of 255 feet below the coal and 682 feet below the surface. The salt water at first threatened to flood the mine, but the hole was successfully plugged, though oil leaked into the mine and was skimmed from the mine water for several years. The oil was a heavy lubricating oil and was associated with salt water and gas.

No great excitement such as is now usually manifested attended the discovery. A few holes were drilled, however, and in 1882 four wells were being pumped, each producing, according to Worthen, about two barrels of oil per day. In 1882 the first big gas well was brought in. It had an initial pressure of 400 to 450 pounds per square inch, but in 1885 in drilling deeper, salt water was struck and the well was spoiled.

In the same year two other gas wells were brought in which had a pressure of 125 pounds per square inch. The gas was piped to Litchfield (a distance of about $1\frac{1}{2}$ miles) by the Litchfield Gas, Oil, and Fuel Company and was used for cooking and lighting for several years. In 1886 about 500 stoves were supplied, but in 1889 the supply of gas was equivalent to only 12 tons of coal per year, which was all consumed in

⁶Worthen, A. H., Geol. Surv. of Ill., Vol. VII, p. 37, 1883.

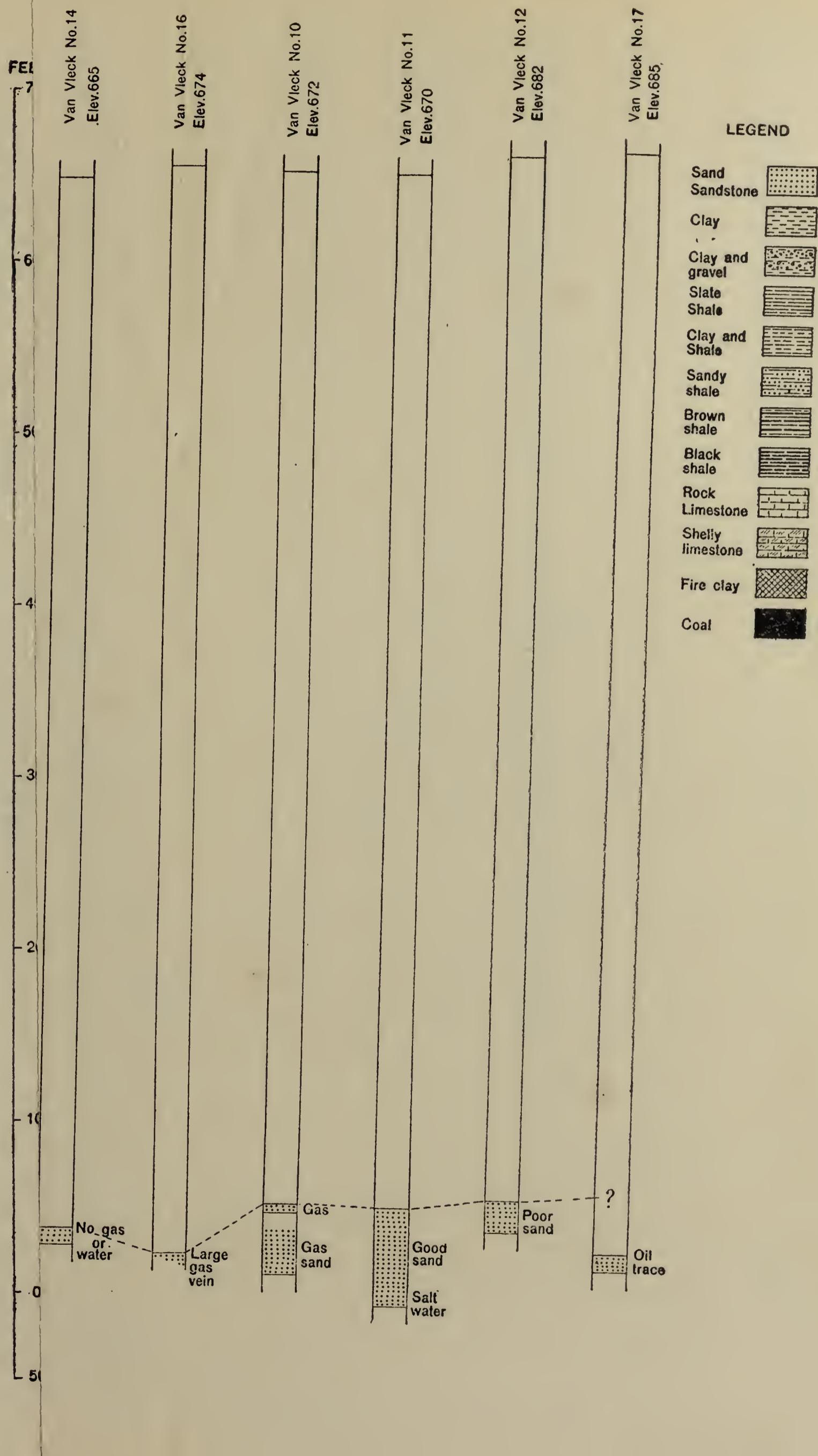
pumping oil. There were never more than four or five oil wells being pumped at any one time, though they were reported to yield about 4 barrels per well a day in 1889. In 1904 two of the wells were still being pumped, but were closed down soon after on account of the low price of oil, it was said, though, since the yield had fallen from 1,460 barrels in 1889 to some 200 barrels in 1902, there were probably other reasons. In 1906 new wells were drilled near the old gas wells Nos. 5 and 15, but they were capped and so far as known no attempt was made to pump them. Up to 1889 some 30 wells had been drilled in the area chiefly for gas, but all except the five wells at that time producing oil had been abandoned several years. Since that time there has been sporadic drilling from time to time without any success in extending the limits of the productive area.

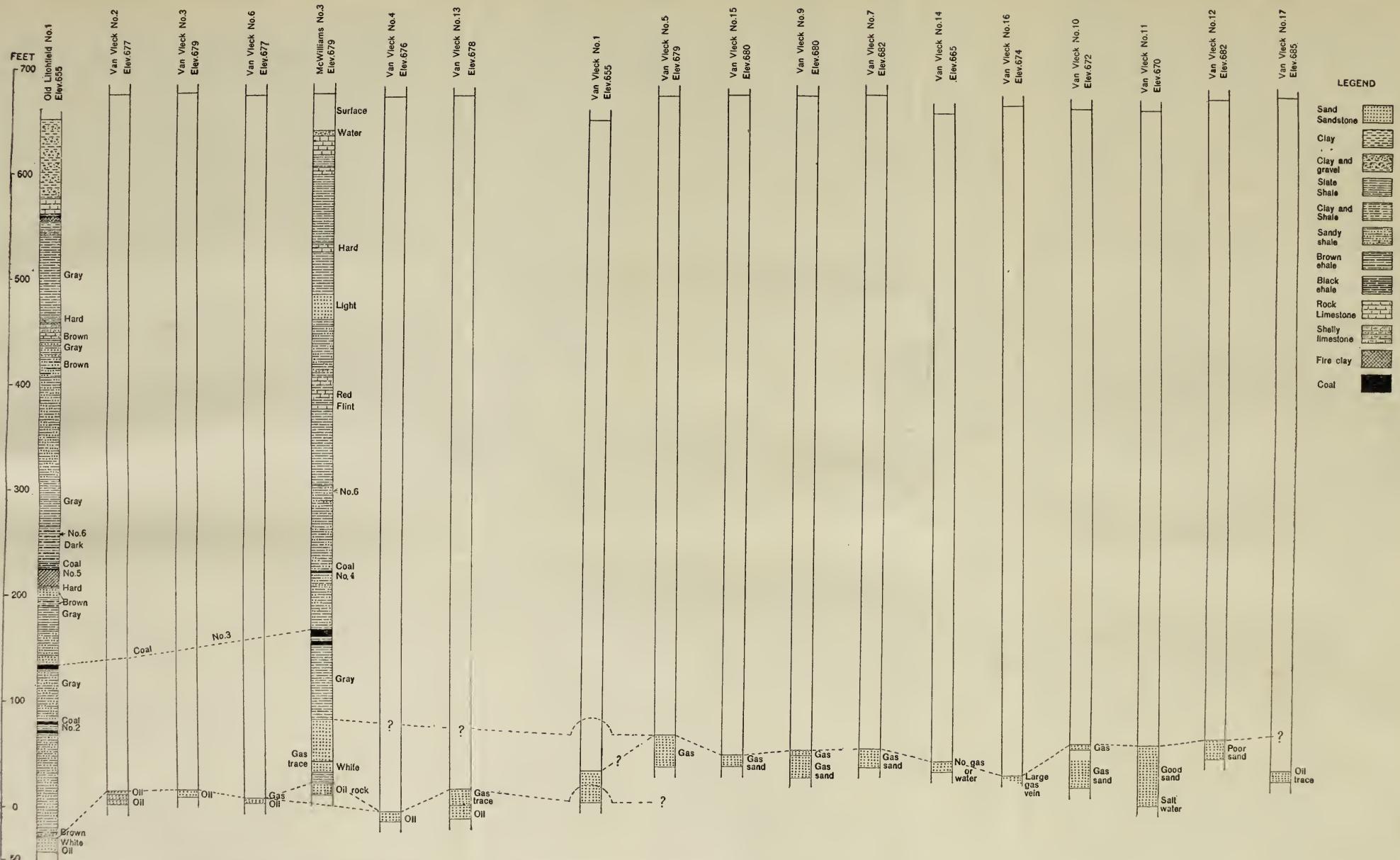
The oil as reported in "Mineral Resources of the United States in 1889" was said to be dark, almost black and to have a specific gravity of 22° B. The cold test was remarkable, the oil remaining fluid at 20° Fahrenheit. It was used chiefly by factories in the neighborhood of Litchfield and was sold at nearby points for lubricating purposes at 8 to 10 cents per gallon.

From the time of its discovery until 1902 the production of oil and gas in Illinois was the production of the Litchfield pool. Between 1889 and 1902 the yield fell from 1460 barrels to 200 barrels per year. During this period 6,756 barrels were produced. In October, 1882, Professor Worthen of the Illinois Geological Survey reported that four wells were in operation, producing two barrels each per day, equal to 2,920 barrels per year. Assuming a gradual decrease from this time until 1889 when the yield was 1,460 barrels, the production for these years was 13,875 barrels, making a total production between 1883 and 1902 of 20,451 barrels, which is doubtless somewhat below the total production since no account is taken of the production between the discovery in 1879 and 1883. The total production was probably not far from 22,000 barrels.

The structure of the rocks of the area near Litchfield based on that of Herrin (No. 6) coal shows a very distinct dome. The same coal beds found in the oil wells east of Litchfield are about 70 feet lower in the mine in sec. 33 of the adjoining township, scarcely more than a mile distant. The dip of the beds toward the southeast is apparent from the limestone outcrops in the creek southeast of town followed by the C. C. C. & St. L. Railway. Toward the west the dip is less pronounced, the horizon of the Herrin (No. 6) coal at the test hole at the southwestern corner of Litchfield being only about 40 feet lower. Toward the south the dip near the oil pool is not known, but it is at least 30 feet lower three miles distant. It is probable that the dome just described was the essential factor in causing the accumulation of the oil in the Litchfield pool.

Of the older wells six produced oil and seven produced gas. The oil holes lie in almost a straight line in a tract about one-half mile long





Graphic sections of Litchfield well
(For location of wells see figure 17)

and one-eighth mile wide. The gas holes, however, are sprinkled over a slightly wider area as may be seen from the accompanying sketch map (fig. 17). Plate VII shows the position of the oil and gas sands in the different holes. It will be seen that the gas wells lie chiefly to the east of the oil holes, and that the gas was reached in a sand which lies 40 or 50 feet higher than the oil sand. The distance between oil well No. 13 and gas well No. 5 is scarcely more than 500 feet, yet the gas sand is nearly

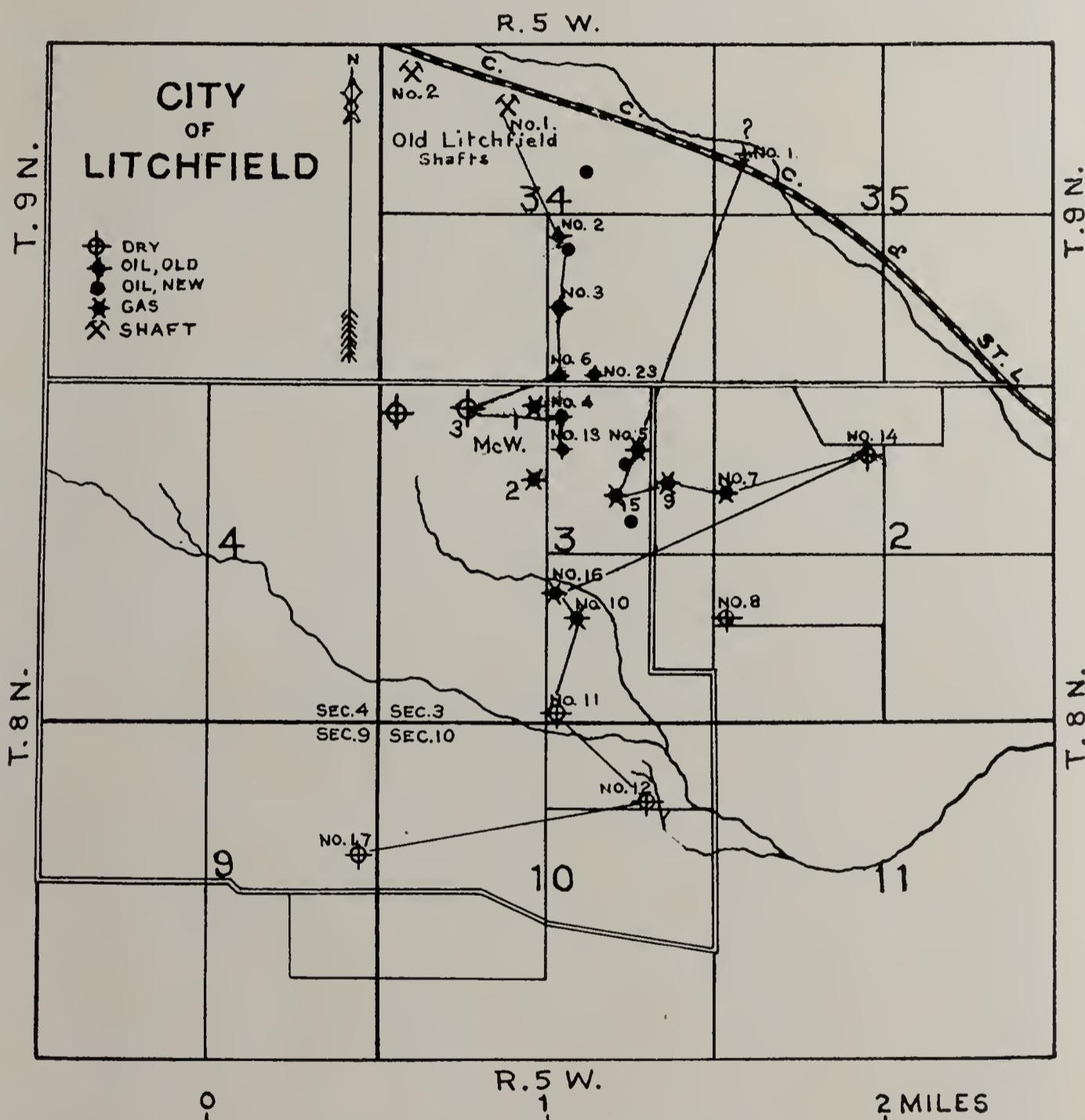


FIG. 17. Map showing location of wells in Litchfield pool and order of arrangement of logs in Plate VII.

50 feet higher than the oil sand as shown by the correlation lines on Plate VII. This is not easily accounted for, either by flexure or by faulting, since sharp displacements of the strata in so short a distance due to either of these causes are not known in this part of Illinois. The most plausible explanation of the phenomena lies in the probable presence of more than one sandstone bed, the upper of which was gas-bearing, whereas the lower was productive of oil. The fact that at the time the field was being

exploited the gas was of more consequence than the oil and the fact that the first gas well was lost by the influx of salt water while drilling the hole deeper, offers an explanation of the failure to drill deeper in the eastern part of the field. No complete records of the early drilling have been preserved, and it is not now known whether the gas sand extended westward above the oil sand in the area of the earlier producing wells. This seems in some respects not unlikely since a gas-bearing sand is reported at the same horizon in the McWilliams well west of hole No. 13, though no upper gas sand was reported in the surviving fragmental logs of the oil holes.

It is probable that the oil sand extends beneath the horizon of the gas sand in the eastern part of the field. In 1906 two new wells were drilled near the abandoned gas wells No. 5 and No. 15, both of which were reported to be oil bearing. Whether the holes reached the oil stratum below the exhausted gas sand, or whether oil during the 16 years since the exhaustion of the gas had found its way into the formerly gas-bearing horizon is not known. The wells were capped over without being pumped, and it seems probable, therefore, that but little oil was encountered.

The productive sands in the Litchfield field, as well as in the Carlinville field, occur at and below the horizon of the Murphysboro (No. 2) coal. In the old Litchfield shaft where the first discovery was made, the oil sand lies below the horizon of the coal No. 1 and below the natural position of this coal in the McWilliams well No. 3. The sands from which the chief gas production has come seem to lie higher in the section and in the McWilliams well No. 3 this sand seems to lie at the elevation of coal No. 1 and probably cuts it out. The significant feature is that, although the sands are not continuous, the oil- and gas-bearing lenses correspond very closely in stratigraphic position to the oil and gas sands in the Carlinville area and were it not for intervening logs which clearly show the absence of this sand the beds might easily be correlated. In spite of the frequency of more or less extensive sand bodies higher in the Carbondale and McLeansboro formations no oil has ever been found in them, only pockets of gas being present.

The conditions are somewhat analogous to those existing in the Carlinville field where, although the doming of the rocks appears to be the controlling factor in the accumulation of the oil, the character of the sand-stone lenses appears to have been the deciding factor in determining what particular part of the dome should be the repository of oil. The association of gas in a higher sand with oil in a lower, possibly connecting, bed is also a parallel circumstance.

Only a few complete logs have been preserved so that a complete analysis of the field is now impossible. The field will never again reach its former production, but it seems possible on account of the high viscosity

of the oil that considerable oil yet remains in the developed area, and that by drilling to the east of the old oil wells a modest production may be expected from the deeper sand. The viscosity of the oil preventing its easy extraction from the sands would seem to warrant the closer spacing of the holes and the use of modern devices for more complete extraction. The area has never received systematic development and though there is a possibility of future production on a small scale the returns will not be high. No information is available as to whether the holes were plugged, but it is probable that some were abandoned without plugging. What effect this may have had on the oil yet in the ground is problematical.

CARLINVILLE OIL AND GAS FIELD

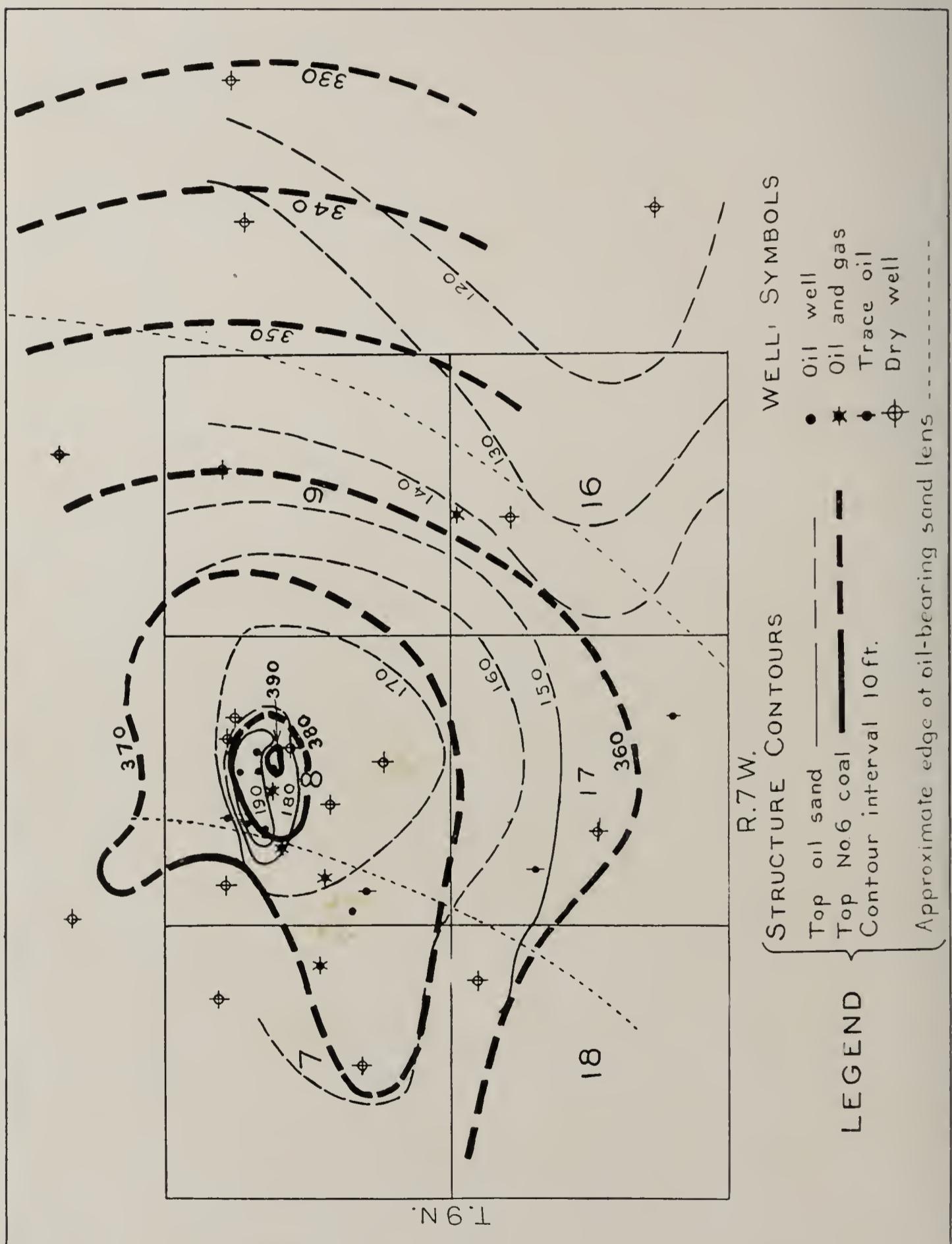
The first knowledge of gas in the Carlinville area was obtained in the early sixties when a water well was being dug in the glacial drift in sec. 7, T. 9 N., R. 7 W. The man engaged in digging the well is said to have paused in his work to light his pipe, thus igniting a small pocket of gas, which the story relates set fire to his clothing. Led by this discovery, a well was drilled in 1867 near the east quarter corner of sec. 7; but the hole was unsuccessful, and prospecting was abandoned. In 1909 prospecting was renewed in the same area by the Impromptu Exploration Company, directed by Mr. T. A. Rinaker, and a small gas field was developed which was sufficient to provide illumination for Carlinville for two or three years. Continued exploration toward the east in November, 1911, developed a small oil pool which has had a reported production up to the close of 1914 of 16,540 barrels. An isolated gas well was drilled in the early part of 1912 on the Hammann farm near the center of the north line of sec. 16, T. 9 N., R. 7 W. The pressure is said to be between 85 and 90 pounds, but the owner was unable to come to terms with the Litchfield gas company and the well is now capped, and no effort is being made to use the product. The bottom of the well is 507 feet below the surface and 295 feet below the top of the Herrin (No. 6) coal. The gas comes, therefore, from the lowest of the Pottsville sands recognized in this area.

The gas in the Carlinville area was reported to be of good quality and similar to that at Greenville and Jacksonville. It is said to have been almost odorless and colorless, and to burn with a hot, blue flame. The initial pressure was 135 pounds but in 1912 it had fallen to about 35 pounds.

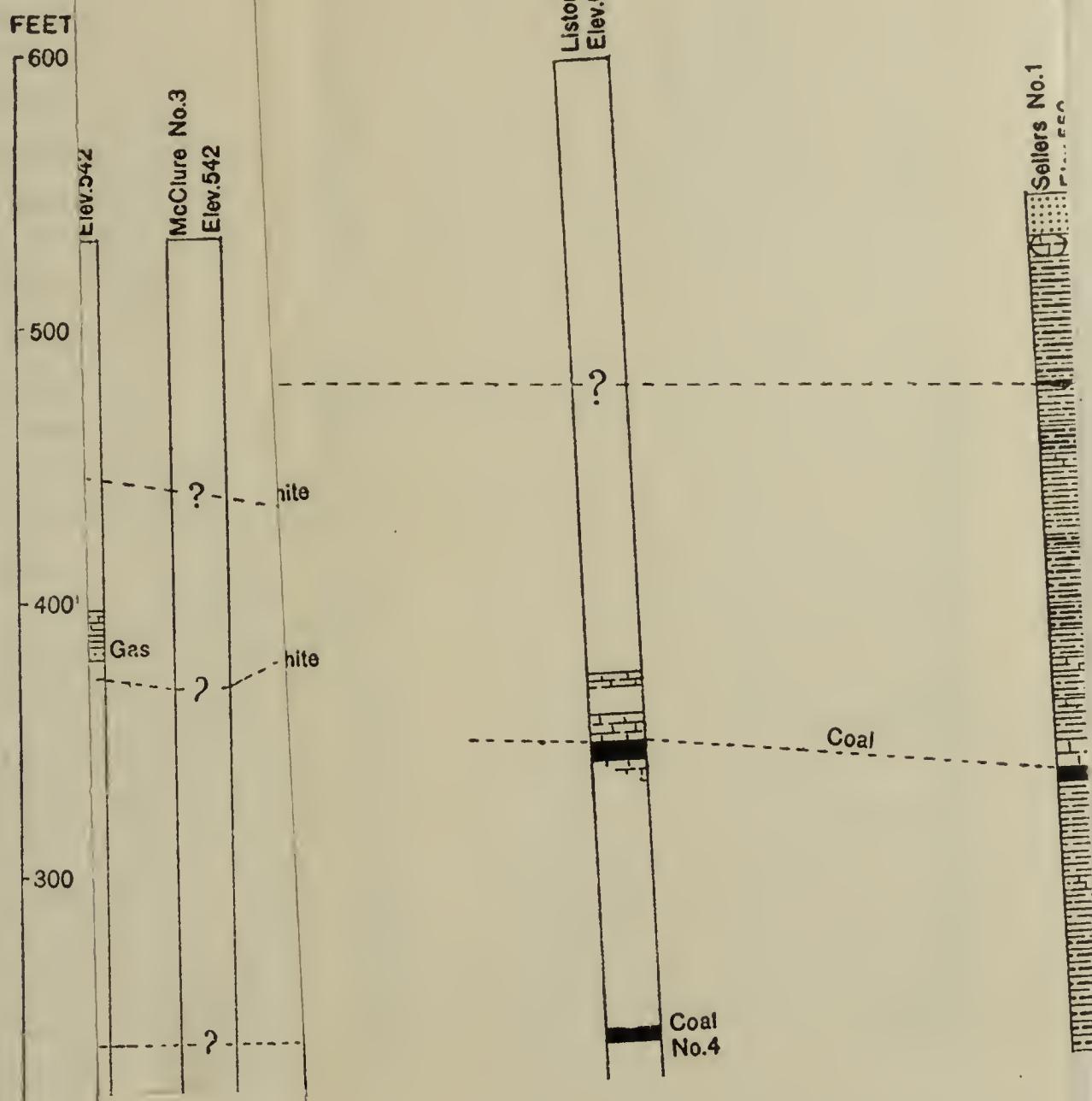
The oil is dark brown and semi-viscous and has a specific gravity of 28.6° B. It is said to resemble the oil formerly produced in the old Litchfield pool and the Duncanville heavy oil of Crawford Company, though the former was considerably heavier than that found here.

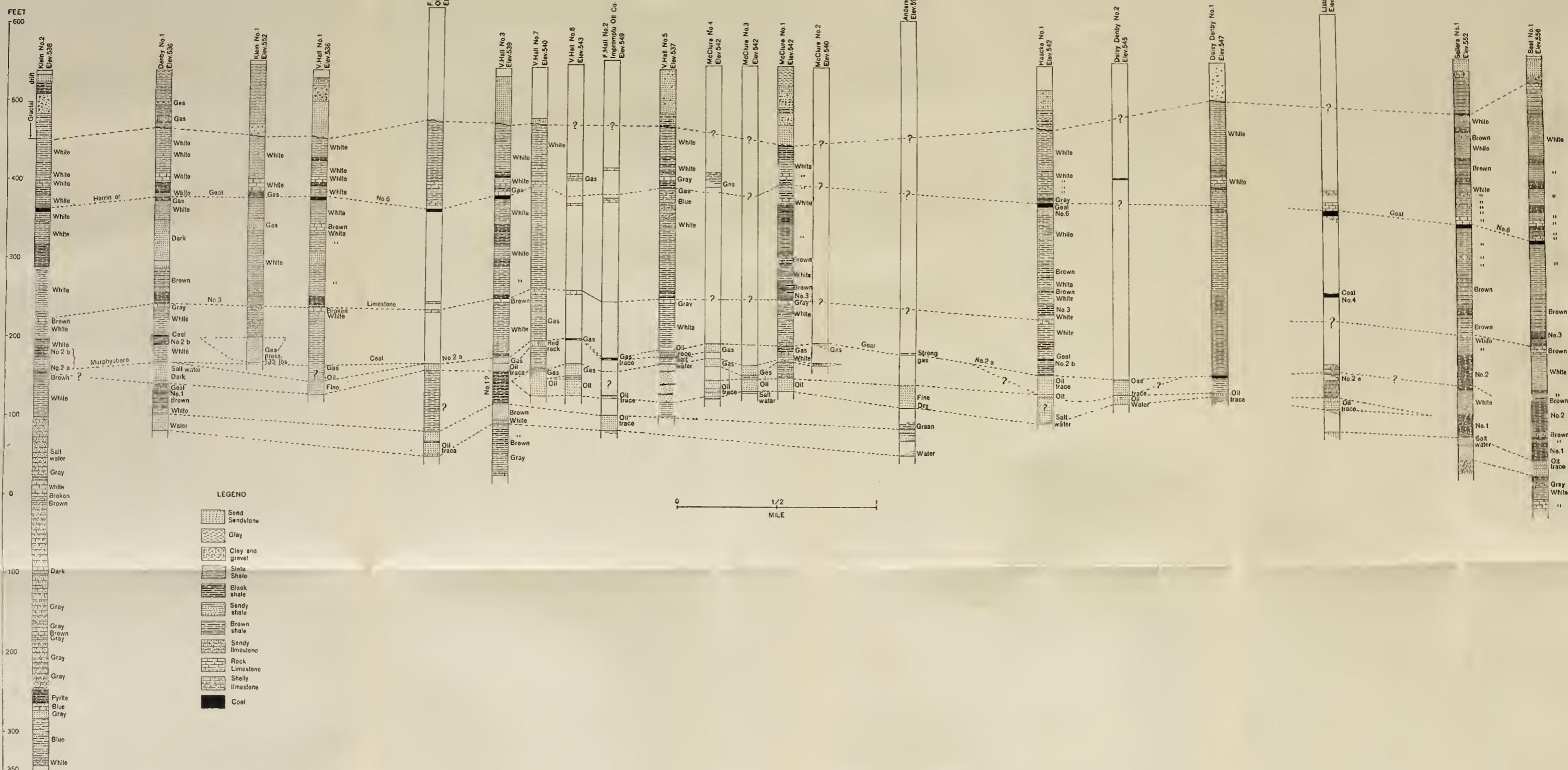
The structure of the oil- and gas-producing area at the horizon of the Herrin (No. 6) coal is a low dome crowning a long eastward-sloping surface having a dip of about 10 feet to the mile. The height of this dome

does not exceed 20 feet at the horizon of the Herrin (No. 6) coal, but at the horizon of coal No. 3 and its accompanying limestone bed, and at the uppermost of the gas-bearing sands, the dome is accentuated as may be seen on Plate VIII. Figure 18 shows the dome by contour lines on the



Herrin (No. 6) coal and on the highest sandstone bed. As may be seen, the deformation of the two surfaces is practically concentric. The Herrin (No. 6) coal bed has, however, not been reported in all the logs, and it has





Graphic sections of Carlinville wells
 (For location of wells see figure 19)

been necessary to determine its position in some of the wells by correlation of the logs on the overlying limestone and black shales. This may account for the apparent deviation.

Whereas the doming of the rocks at this point was probably a very important factor in localizing the oil pool, other factors such as the slope, continuity, and porosity of the sand beds at different places were equally important. The discontinuity of the sandstone beds was recognized by F. H. Kay⁷ who reported the field in 1912, but no attempt was made at that time to distinguish the productive sandstone lentils. Several new wells have been drilled in the past two or three years, and it now seems possible to distinguish four productive horizons only one of which, however, has been commercially profitable.

Plate VIII shows the essential relations of the various sandstone horizons to one another. A little gas has been reported in several wells in the black shale immediately overlying the Herrin (No. 6) coal. The highest gas-bearing stratum of any importance, however, was penetrated by the Klein No. 1 well, which passed into 30 feet of gas sand at a depth of 350 feet. The horizon of this sand is that of the upper bench of the Murphysboro or No. 2 coal, which, if no error has been introduced in reporting the log, has been replaced at this location by sand. The fact that no sand was reported at this position in either Denby No. 1 or V. Hall No. 1 wells one-half and one-fourth mile distant respectively, nor in any other log in the field except the Mutzbauer well in sec. 23, T. 9 N., R. 8 W. suggests either that the gas comes from an isolated sand lens, or that an error has crept in the log, and that its actual position is somewhat deeper. The sand reported in the Mutzbauer well seems to substantiate the log of the Klein No. 1 well, at the same time suggesting a zone of sandstone lentils above the sands about to be described. The possibility of sharp flexure at this point seems to be discounted by the regularity of the sandstone below the Murphysboro (No. 2) coal and by limestone accompanying coal No. 3 group.

The next sand bed of interest lies 20 to 25 feet below the upper bench of the Murphysboro (No. 2) coal and is closely overlain by a bed of black shale, which may represent the lower part of the Murphysboro (No. 2) bed itself, this bed appearing in several of the logs in other parts of the quadrangles as a bifurcated seam. In the central part of the area this bed, which is gas-bearing at nearly every point penetrated, has a thickness of 6 to 8 feet with thin breaks enclosing, in one or two places, thin sheets of slightly oil-bearing sand. It thins toward the east and south, but even where no sand was reported the overlying black shale was found to contain some gas.

⁷Kay, F. H., The Carlinville oil and gas field: Ill. Geol. Survey Bull. 20, 1912.

In the Haake No. 1 well in sec. 17 a sandstone bed immediately underlies "black slate" at the horizon of the lower bench of the Murphysboro (No. 2) coal. This is thought to represent in part a sandstone lens deposited in a channel cut down into a lower sand with the essential relations shown at A in figure 20. The sandstone reported in the V. Hall No. 1 well also probably represents a similar thickening of this sandstone, as does also the upper sand in Denby No. 1. This bed has been productive of a moderate quantity of gas and a little oil, but the sandstone which lies just below has been more productive.

The chief oil and gas horizon is commonly separated from the bed just described by 15 to 25 feet of shale. It lies at the horizon of coal No. 1 about 385 feet below the flood plain of Macoupin Creek and appears to lie in a channel cut into the beds somewhat later than the deposition of this coal. The reason for so regarding it, is that although this productive sand horizon is present in the wells drilled east of a general northeast-southwest line drawn between the V. Hall No. 3 and V. Hall No. 7 wells, it is absent to the west. In the Denby No. 1 well west of this line this part of the section contains coal No. 1, whereas in the V. Hall No. 3 well at the horizon of coal No. 1, black shale is reported. As black shale is frequently reported in place of this coal in wells in other parts of the district it is thought to be represented in this log.

In the other holes west of this line either the interval is reported as shale, which is a conventional non-committal report in careless logs when no sand is present, or the interval is not reported at all. Whether the sand reported in the V. Hall No. 1 well is really an excessive thickening of the higher sand bed or whether it represents a protruding arm of the lower, more productive sand may be open to question, though the former appears most probable, from its stratigraphic relations. East of the line mentioned all of the holes which penetrate to this depth show sand at the position of coal No. 1.

The chief producing bed is from 30 to 45 feet thick and is split into an upper gas-bearing sand and a lower oil-bearing sand by a break of shale 5 to 10 feet thick. If it were not for the fact that in the Hall No. 7 well these gas- and the oil-bearing horizons are in contact without any intervening shale, the two sandstones might be considered as separate and distinct beds, as indeed they are in effect in most of the wells. It is probable that the shale parting between the beds is absent at other points and that communication from one to the other is thus facilitated, as suggested by the practical absence of oil from the upper bed and of gas from the lower.

In the Anderson well one-half mile to the south of the producing wells, this sand is represented by one bed 27 feet thick lying, on account of the dip, somewhat lower than in that area. Here it is reported to be

very fine grained and nearly dry. In the Freeman Hall No. 2 well drilled by the Impromptu Company only a thin, slightly oil-bearing sand is reported probably about the bottom of the lower part of this member. Adjacent parts of the section are not reported, but whether the sand is actually thicker than reported or not, the fact remains that the oil-bearing portion of this member appears to be present. As already stated the oil- and gas-bearing parts of this sandstone are in contact in the V. Hall No. 7 well without any intervening shale. Toward the west, however, a sudden change is to be noted between this well and the V. Hall No. 3 well, black shale replacing the sand in the latter. No sandstone was reported at the horizon in the log in the Freeman Hall No. 1 well of the Ohio Oil Company, but as the producing member is reported in the Freeman Hall No. 2 well of the Impromptu Company, only a short distance east, a similar wedging out is thought to occur between these holes also.

Still another and deeper sand is encountered below the chief producing sand. It lies about 25 feet below coal No. 1 and appears to be a more persistent and continuous layer than any of the others. It appears in the logs of all the wells in the field which have penetrated to this depth, but it has been found to contain chiefly salt water, though in a few instances, notably the Ohio Oil Company well on the Freeman Hall farm, the Best No. 1 well of the Impromptu Exploration Company, and others, traces of oil and small quantities of gas were observed. Its relations to the higher sands is shown in Plate VIII.

Figure 19 shows the location of all the oil wells drilled in the district. It should be noted that the arrangement of oil and gas wells in the area has little significance since some of the holes report the condition of one sand bed and others of another. They therefore do not indicate any obvious relationship to the structural dome shown in figure 18.

Plate VIII, though primarily designed to show the correlation of the sands, shows also in a rough way the structure of the area in cross-section, the logs being arranged as shown on the key map (fig. 19). Plate VIII is intended to show also that there is no one particular oil or gas sand, but that at and below the horizon of the Murphysboro (No. 2) coal there are present a number of sands any of which under favorable conditions is capable of receiving and retaining oil and gas; that the principal bed in which oil has been found is one which lies at the horizon of coal No. 1; that this bed is not a continuous sheet extending across the area like the coal beds and some of the limestones, but that it occupies what was originally a broad shallow valley cut into the rocks not long (geologically speaking) after the formation of coal No. 1.

This valley which no doubt had the usual irregular configuration of a shallow drain with more or less meandering course and subsidiary tributaries was later filled with silts of sand and mud of more or less varying

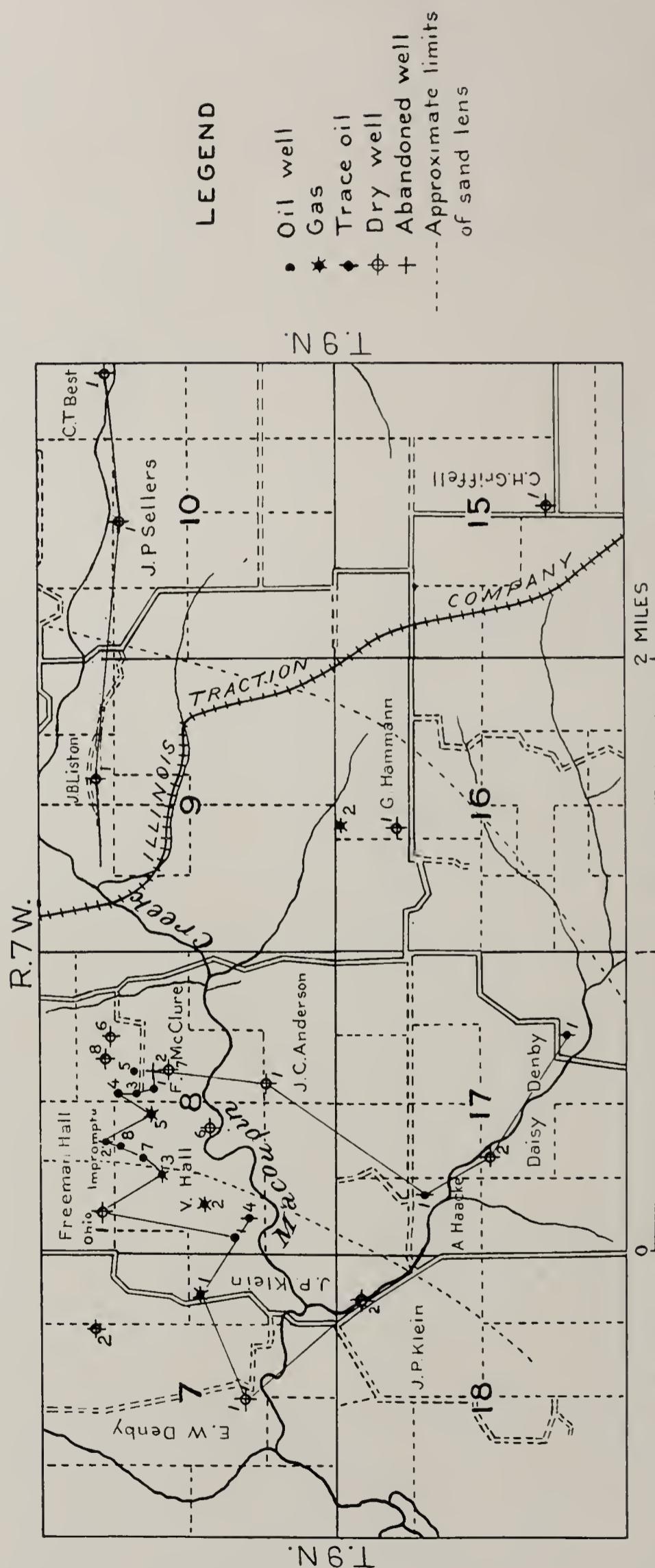


FIG. 19. Map showing location of wells in the Carlinville field and order of arrangement of logs in Plate VIII.

grain and distribution. Sand was deposited at one point and sandy shale or shale at another until the original channel was filled and covered. The

first deposits however seem to have been sands though shale appears in the middle part of the filling in some places.

The width of the sand filling the old basin is not sharply defined by the drilling. It is present in the Liston No. 1 well in sec. 9, but the black shale horizon of coal No. 1 appears in the logs of the Best and Sellers wells in sec. 10. The width of the old valley at this point appears to be about 1½ miles. On the east of the channel the lens is 35 or 40 feet lower than on the west, and there is therefore less opportunity for oil to accumulate since there is a tendency for it to rise toward the highest part of the porous sand body. Small pockets of oil or gas may, however, occur beneath the irregular roof shale, and some may be trapped by so-called "breaks" in the strata, but the eastern side of the sand body at this point is regarded as distinctly unfavorable.

The breaking off of the sand in sec. 7 between the V. Hall No. 7 and the V. Hall No. 3 wells and between the Freeman Hall No. 2 well of the Impromptu Oil Company and the Freeman Hall No. 1 well of the Ohio Oil Company already discussed, indicates that the approximate margin of the sand passes between these wells. To the south it is apparently present in the Haake No. 1 well in sec. 17, where it is unproductive, probably on account of its lower elevation, and absent in Klein No. 2 well in sec. 18, half a mile to the northwest. Toward the north the information at hand is inadequate though the main oil-bearing sand, if present (which is doubtful), might be included in 140 feet of undifferentiated sandy shales reported immediately above the gas sand in a deep well in sec. 5. The gas-bearing sand in this well is believed to be the basal or lowest of the sand horizons recognized in the wells so far drilled. The later deformation and tilting of the beds provided a pocket in the wedge-shaped upturned edge of the lens favorable to the accumulation of the oil particles as they migrated upward through the sandstone. The oil as now found occurs at a point along the edge of the lens where gentle doming of the rocks has capped the edge of the porous strata and effectually prevented the escape of the oil along the bedding planes as shown in figure 20. The doming caused a portion of the sand wedge to be elevated, thus forming a particularly favorable situation for the accumulation of oil and gas.

It is thus seen that, whereas the upturned wedge of sand was a favorable condition, the accidental occurrence at its edge of a gentle dome made the situation especially good for trapping the oil migrating through the porous sands of the old channel.

Although the possible presence of oil and gas in the other sandstones should not be lost sight of, the chief interest naturally centers in the sandstone which has been the chief producer. Future drilling should take into account the form and character of the reservoir in which the oil is found. The most favorable location, as just stated, appears to have been beneath

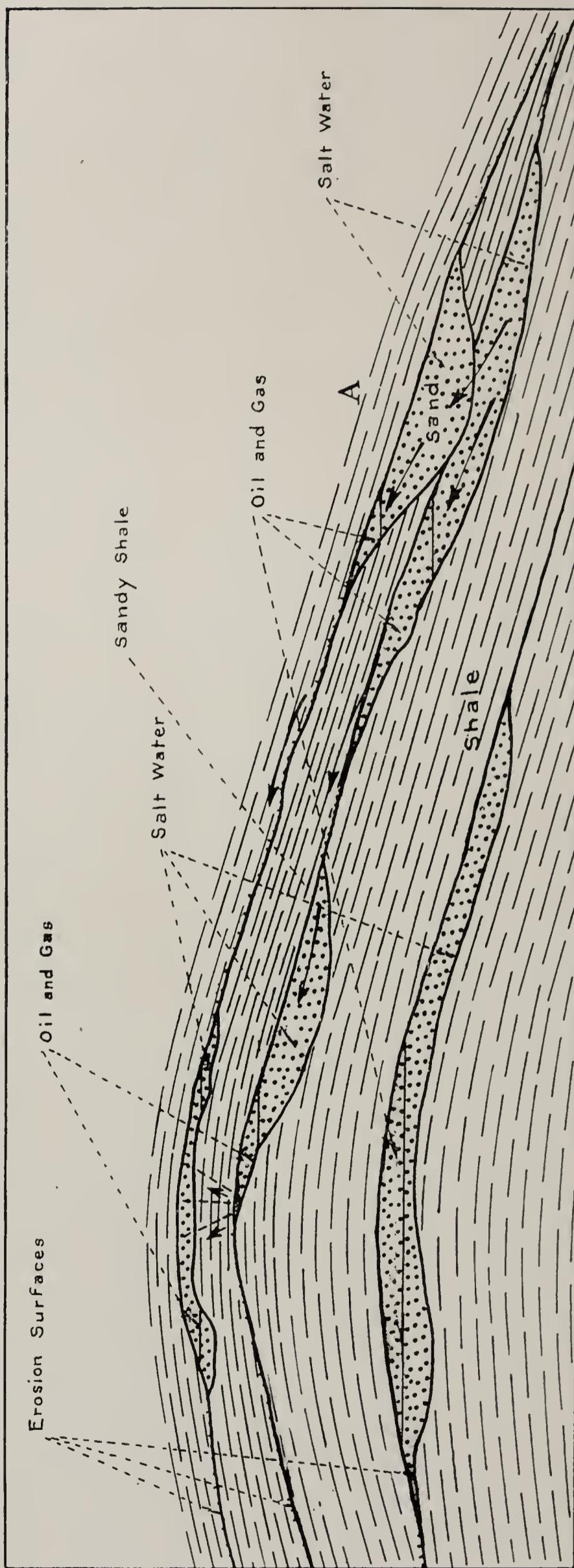


FIG. 20. Idealized section through a dome, showing sand-filled channels in cross-section, points of accumulation of oil and gas, and direction of migration.

the domed edge of the sandstone lens which has already been rather well prospected. The next most favorable situation appears to be along the continuation of the margin of the old channel to the northeast and southwest and on the dip to the east. The dip to the east has been prospected by the McClure wells No. 6 and No. 8, the latter of which was found to be dry at a depth of 500 feet. The F. Hall No. 2 well of the Impromptu Company, though a little oil was found in it, did not give much promise for future prospecting to the north. A hole recently drilled 680 feet north of V. Hall No. 7 is said to have proved dry also. These holes seem to prove the futility of further prospecting in this direction in the immediate vicinity of the dome.

The dome appears to be much sharper on the north side, however, than on the south, so that the probability of slight extension of the producing area toward the south is better. V. Hall No. 6 is the only hole drilled south of the producing area; this hole is at some distance from the probable edge of the productive sand lens, and too far away from the nearest producing well to condemn the intervening territory. The depth to which it was drilled is not known. Favorable unprospected territory probably lies just east of the dotted line in figure 19 and not far south of V. Hall No. 7 well.

The question of the extension of the field seems to turn on whether the reservoir was provided by the dome or by the shape of the sandstone body. If the former was the controlling factor the limits of the pool as outlined at present seem to have been reached. If the latter was alone sufficient to cause accumulation of the oil, then doubtless other producing areas will be found along the edge of the old basin. It must be admitted, however, that even taking into account the probable meandering course and variable nature of the edge of such a sand body, the evidence at hand seems to limit the oil-producing area to the part of the sand beneath the dome.

The area, however, should not be abandoned without investigating the influence of the dome on the lowest sandstone bed. It has been shown by several borings that traces of oil occur in this bed in areas structurally inadequate to effect accumulation and indicate that oil has traversed the bed. An area favorable to accumulation and retention, however, occurs beneath the dome, and as there is reason to believe that this lowest sandstone is there present, the conditions are believed to be worth testing in the lower sand at this place.

GENERAL RELATIONS OF OIL TO STRUCTURE AND STRATIGRAPHY

Whereas the study of the Carlinville and Litchfield oil pools is less satisfactory than it might have been had more detailed logs been available, the information at hand is in many respects unusually good, particularly in the Carlinville field. The small size of this pool makes it possible to

obtain a more comprehensive understanding of the conditions than is usually the case in the larger oil pools. The most important point brought out appears to be that the oil does not occur in distinct, continuous sandstone bodies, but is found in sandstone lenses which are locally discontinuous but which may have been simultaneously deposited in different localities. Thus, whereas the producing sand near Carlinville which is deposited at the horizon of coal No. 1 is of only local development, a similarly situated gas-bearing sand which cuts out coal No. 1 in the Litchfield area in the same manner may be its stratigraphic equivalent, though there is no direct connection between them.

Another point plainly indicated is that although the doming is important and probably is the ultimate controlling factor in causing accumulations of oil and gas, the position, shape, and inclination of the sand lenses is also important in governing the local relations of the oil to the dome. It will be readily understood that the upturned edge of a sandstone lens is in some respects favorably suited to the trapping of oil. There is, however, a tendency for the oil and gas to escape along the bedding planes of the enclosing strata as indicated by the arrows in figure 20. There must also be a tendency for these materials to travel longitudinally along the edge of the wedge unless this is horizontal or the irregularities in deposition of the sand present barriers to such circulation.

It should be evident then that it is possible for accumulations of oil to take place where no deformation at all is present, but so far as known oil has not been observed under such conditions in western Illinois. It is probable, therefore, that sandy, and usually micaceous, shales enclosing the sandstones in the lower Pennsylvanian are not sufficiently close grained or impervious to prevent the circulation and escape of oil and gas under pressure along bedding planes.

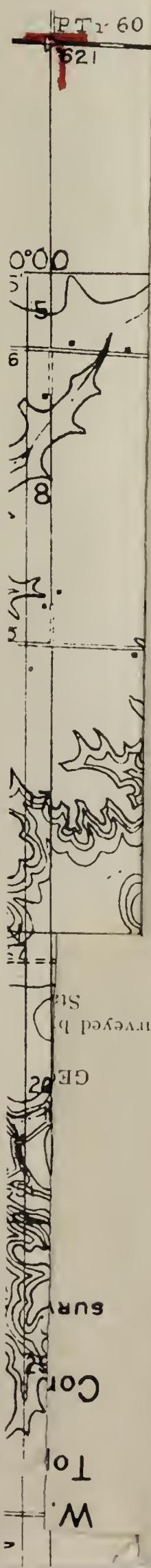
The occurrence of a dome at the edge of a sand lens unquestionably prevents the escape of oil in the manner suggested, except in so far as minor losses occur transverse to the overlying beds.

The accumulation of oil, therefore, while occurring beneath a dome (except where it is found in a continuous sandstone stratum or in a lens completely underlying the dome), is likely to have an eccentric distribution in regard to the structure, no oil at all occurring on one side of the dome. These conditions are shown graphically in figure 20, the arrows indicating the probable direction of migration of the oil and gas.

The presence of impervious parts in a sandstone bed would tend to restrict the oil to the more porous parts of the bed. Therefore, a single unproductive well drilled into a producing sand at a point where the sand was locally close grained need not necessarily condemn the immediately adjacent territory, though of course this is often the case.

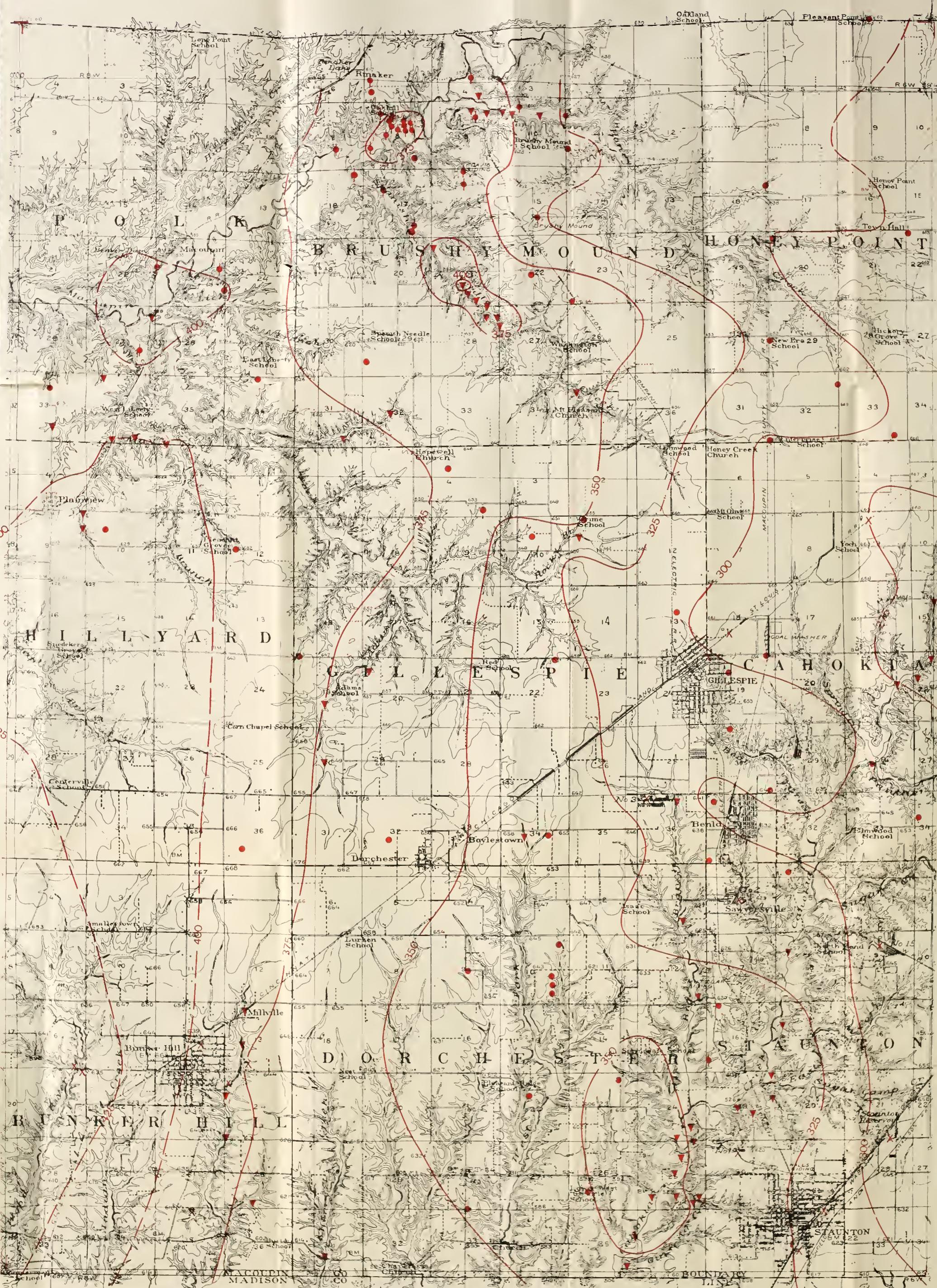
The movement of oil, gas, and salt water from one part of a sandstone

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U. S. GEO
GEORGE OT



ILLINOIS STATE GEOLOGICAL SURVEY
GOVERNOR L. L. DUNNE, T. C. CHAMBERLIN, E. J. JAMES, COMMISSIONERS
FRANK W. DE WOLF, DIRECTOR

BULLETIN NO. 31, PLATE IX



R. B. Marshall, Chief Geographer
W. H. Herren, Geographer in charge.
Topography by Frank Tweedy, C. W. Goodloe,
L. L. Lee, and R. M. Herrington.
Control by J. H. Wilson and R. G. Clinke.
Surveyed in 1912
SURVEYED IN COOPERATION WITH THE STATE OF ILLINOIS

Scale 1:80,000

1 2 0 1 2 3 4 Miles
4000 2000 0 4000 8000 12000 16000 Feet
1 2 0 1 2 3 4 Kilometers

Contour interval 20feet.

Datum is mean sea level

TOPOGRAPHY AND GEOLGIC STRUCTURE, GILLESPIE QUADRANGLE

LEGEND

- Diamond drill
- ◆ Churn drill
- ✗ Mine shaft
- ▼ Rock outcrops used

300 Contour showing elevation of top Herrin (No. 6) Interval 25 feet

APPROXIMATE MEAN DECLINATION 1912

series to another by interconnecting sand lenses is suggested in the idealized sketch in figure 20. At the point marked "A" deposition of sediment gave place to erosion, and a local channel was cut sufficiently deep to expose the underlying sand body. This being later filled with pervious sand furnishes an escape into higher strata in the manner indicated by the arrows.

A careful study of all the available logs indicates that above the Herrin (No. 6) coal the deformation of the lower beds is closely reflected in the upper beds; the structures are shown in the succeeding overlying beds in the same localities. The higher beds above the Herrin (No. 6) coal, however, appear to be more deformed than the lower beds in anticinal areas. This appears to be due to a consistent thickening of the intervals between recognizable datum planes at points of bending, so that in anticinal areas the deformation is accentuated, and in synclinal areas the structures are softened in passing upward from the Herrin (No. 6) coal. What the explanation of this phenomenon may be, or whether it is even a general fact of importance beyond the confines of this area can not now be said. The only area in which this relation between structure and depth could be studied below the Herrin (No. 6) coal is that of the Carlinville oil pool. Here the reverse appears to be true, the dome which characterizes the structure of the producing area being much less pronounced at the horizon of the Herrin (No. 6) coal than below. Whatever the quantitative relation between the deformation at different horizons, the fact remains that deformation at one horizon is usually significant of similar deformation beneath. A single possible exception to this rule was found where a slight deformation of the Carlinville limestone failed to be reflected in the beds below, but as some doubt exists at this point as to the presence of the true Carlinville limestone, the exception is not damaging to the general conclusion. Eccentricity of the position of the oil beneath the domes, however, has already been explained.

ANTICLINAL AREAS FAVORABLE TO THE ACCUMULATION AND RETENTION OF OIL AND GAS

As has already been stated, in these quadrangles the surface of the coal on which the conception of the structure is based is very irregularly warped, rises brokenly from east to west, and attains an elevation on the west approximately 275 feet higher than on the east. Besides the domes in the oil-producing areas near Carlinville and Litchfield already described in detail, a number of other more or less sharply accentuated domes were discovered which are shown in Plates IX and X.

STAUNTON DOME

The Staunton dome previously described by R. S. Blatchley,⁸ appears to lie somewhat farther west than appeared from the evidence available at

⁸Blatchley, R. S., Oil and gas in Bond, Macoupin, and Montgomery counties; Ill. State Geol. Survey, Bull. 22, p. 41, 1913.

that time. The dome is low, having an elevation, so far as known, of only about 25 feet above the lowest point to the south. It is about 3 miles long and $1\frac{1}{2}$ miles wide within the 350-foot contour line and the highest known point of the coal within this area lies near the margin and is 15 feet higher. Only points about the margin of the dome are known, however, and it is possible that near the center the coal is higher and that the dome is more pronounced than present information indicates. Toward the east the coal surface slopes rather gently to the next lowest contour elevation; toward the north and west it falls to 330 feet before rising again to the west; at the south end, however, it is separated from the westward-rising slope by a narrow saddle, probably not lower than 340 feet. As there are no exposures or wells in the central part of the dome, only prospecting can determine whether the central part rises sufficiently high to trap effectively the migratory oil in the sandstone beds without the existence of sandstone lenses. The highest part of the dome lying above the 350-foot contour contains the southwest and southeast corners of secs. 13 and 14 respectively, the east half of secs. 23 and 26, the west half of secs. 24 and 25, and the northeast and northwest quarters of secs. 35 and 36 respectively.

SPANISH NEEDLE CREEK DOME

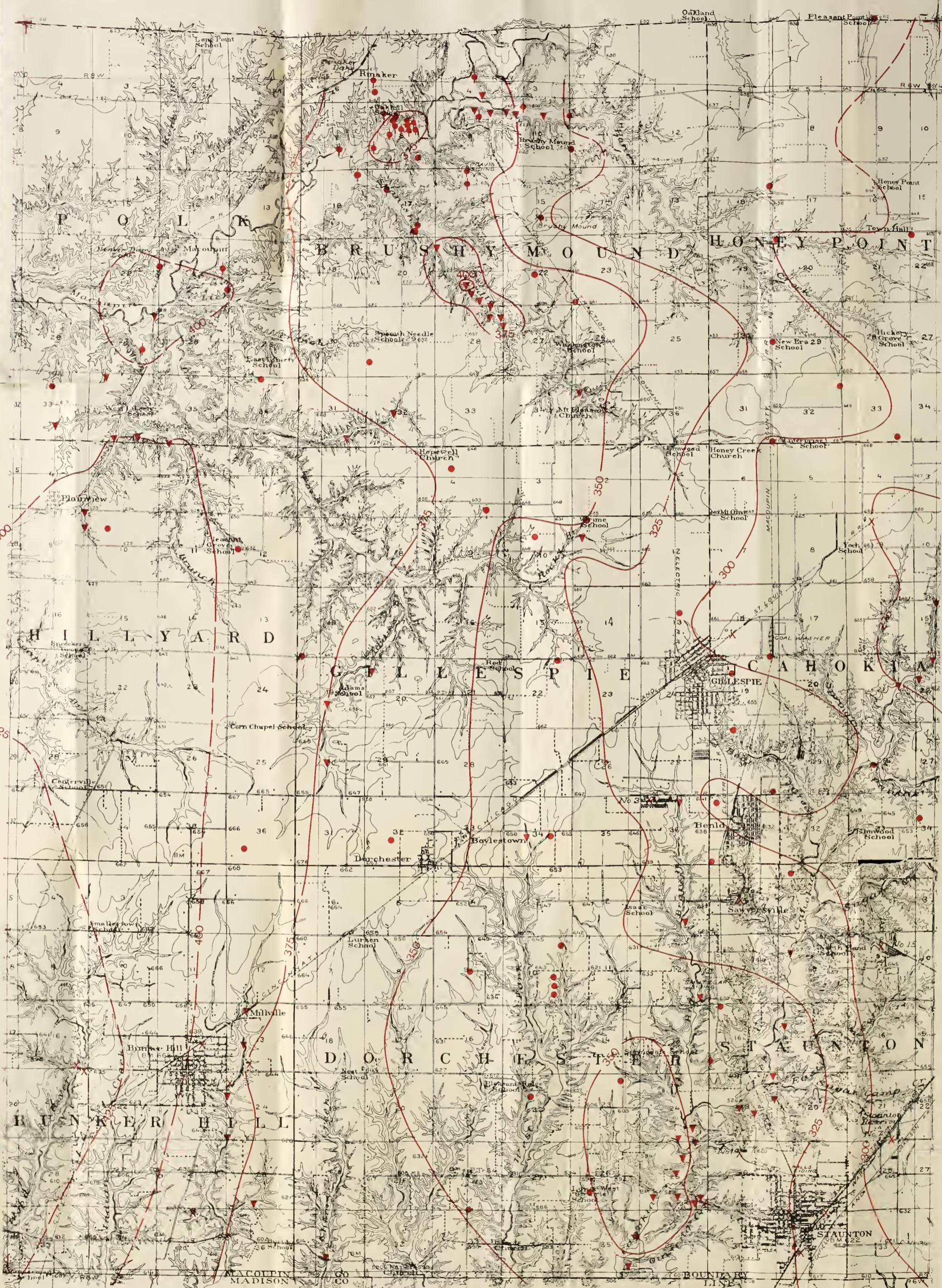
One and one-half miles slightly east of south from the Carlinville gas and oil pool a series of exposures of the Carlinville limestone in Spanish Needle Creek indicate a rather sharp dome which, if transmitted downward to the coal and sandstones, denotes a deformation of nearly 45 feet at the horizon of the oil sands. The highest point of the dome as indicated by the limestone outcrops, lies at the center of the northeast quarter of the southwest quarter of sec. 21, T. 9 N., R. 7 W. A subordinate point on the same dome lying nearly as high was noted at the SE. $\frac{1}{4}$ NW. $\frac{1}{4}$ NW. $\frac{1}{4}$ sec. 28. That part of the coal which lies above the 375-foot contour underlies an area in sec. 21 and the NE. $\frac{1}{4}$ sec. 28, T. 9 N., R. 7 W. about $1\frac{1}{2}$ miles long and of indeterminate width. The highest limestone outcrop represents an elevation of 407 feet in the coal and the subordinate high outcrop to the southeast represents a height of 395 feet. The axis of the dome probably extends from northwest to southeast.

Toward the east the surface of the coal slopes off toward the next lowest contour. Toward the northwest the lowest point is 362 feet near the center of sec. 17, indicating a gentle slope in this direction. Toward the west there is little information in the immediate locality, but in sec. 29 two miles to the southwest the elevation of the coal sinks to 365 feet. Toward the east and southeast the surface of the coal merges into the general southeastward sloping surface.

If the producing sandstone lens, discussed under the subject of the Carlinville oil and gas pool, maintains a constant width of one and one-half miles, its eastern edge may in part underlie the northwestern slope of this

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GEORGE C.





R. B. Marshall, Chief Geographer
W. H. Herron, Geographer in charge
Topography by Frank Tweedy, C. W. Goodlove,
L. L. Lee, and R. M. Herrington
Control by J. H. Wilson and R. G. Olinite.
Surveyed in 1912
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Scale 1:6000

1 2 0 1 2 3 Miles
6000 2000 0 4000 8000 12000 16000 Feet
1 2 0 1 2 3 Kilometers

Contour interval 20 feet.
Datum is mean sea level

TOPOGRAPHY AND GEOLGIC STRUCTURE, GILLESPIE QUADRANGLE

APPROXIMATE MEAN DECLINATION 1912
No. 1
SUE NORTH
NORTH
No. 2
P. Tr. 72
L. G. S. A. M. AR.

LEGEND
 ● Diamond drill
 ♦ Churn drill
 X Mine shaft
 ▽ Rock outcrops used
 Contour showing elevation of top Herrin (No. 6) coal above sea level Interval 25 feet

dome. However, if the deformation of the lowest and most persistent sandstone bed is as great as appears from the surface rocks it should furnish a promising location for oil independent of the relation of lenticular sand bodies.

SOUTH LITCHFIELD DOME

An anticlinal structure of uncertain outline appears to lie about four miles southwest of Litchfield. In the northeast quarter of sec. 25, T. 8 N., R. 6 W. and in the same quarter of sec. 20, T. 8 N., R. 5 W., the Herrin (No. 6) coal was found to lie at an elevation of 260 feet. Midway between in the SW. $\frac{1}{4}$ sec. 20, T. 8 N., R. 5 W., the No. 6 coal was found in a drill hole at 300 feet, 40 feet higher. Two other intermediate holes give intermediate elevations of the coal. Nothing more is known regarding the dome or its configuration, though the surface has been shown conventionally on the map as grading evenly toward the nearest known elevation, in some cases several miles distant. The 700-foot oil well in the NE. $\frac{1}{4}$ sec. 20, T. 8 N., R. 5 W. was drilled in 1906 without success. It should be noted, however, that the highest observed point of the dome is a mile to the southwest of this well.

BUTLER ANTICLINE

Outcrops and drill holes northeast of Butler combine to indicate that the area from sec. 25, T. 9 N., R. 5 W. to sec. 4, T. 9 N., R. 4 W. is distinctly higher structurally than neighboring areas. To the south and east of Butler the datum plane slopes away perhaps not so smoothly as shown at the rate of 20 to 25 feet to the mile, whereas outcrops in Shoal Creek indicate that there is also a slope to the north or northwest in sec. 13, 14, and 23, T. 9 N., R. 5 W. A small dome seems to be indicated just outside the area by the unusual elevation of certain strata in a well drilled in the NE. cor. sec. 4, T. 9 N., R. 4 W. This well was reported to yield a small quantity of oil.

An anticlinal area is indicated on Shoal Creek by the rise of the Shoal Creek limestone from 576 feet in the NE. cor. sec. 23 to 600 feet in the NE. cor. sec. 25, and its fall again in the NW. cor. sec. 36 to 560 feet. Near the crest of this arch Schaffer and Smathers drilled a hole in January, 1915, which penetrated a sand at about the horizon of the Litchfield productive sands. It was reported to be dry, but it contained a black, asphalt-like stain which yielded a faint rainbow on washing. The presence of asphaltic material under the circumstances of its occurrence here is a little difficult to explain. It appears that the sandstone in which it occurs, is a lens lying at the same horizon as, but not necessarily connected with, the Litchfield sand. It appears also that it was once a repository for oil, and that the oil escaped elsewhere perhaps in part as gas along bedding

planes, leaving a residual asphalt adhering to the grains which in the absence of actively circulating water has never been removed.

The oil well and dome in sec. 4, T. 9 N., R. 4 W., the area of high land northeast of Butler; the anticline in the Shoal Creek limestone on Shoal Creek; the Litchfield dome and the dome southwest of Litchfield all lie along the gentle anticline extending at least 8 miles northeast and 4 miles southwest of the Litchfield pool.

Oil is or has been present in three of the structural features mentioned—the Litchfield dome; the dome in sec. 4, T. 9 N., R. 4 W.; and in the anticline on Shoal Creek where the former presence of oil seems to be indicated by the asphaltic sand. The presence of oil in these structures along the anticline points to its possible presence at other places where sandstone bodies favorably situated and of favorable lithologic characteristics coincide with anticlinal structure. It may be said that the entire length of the anticline is favorable territory, though the most favorable area outside the recognized domes seems to lie northwest of Butler in secs. 7, 8, 9, 17, 18, 19, and 20 of T. 9 N., R. 4 W. and parts of secs. 13 and 24 of T. 9 N., R. 5 W.

MACOUPIN DOME

A good shale exposure at the railroad bridge over Macoupin Creek in NE. cor sec. 27, T. 9 N., R. 8 W., shows the beds to dip about 10° southeast into the bank of the creek. Logs of holes one-half miles south and one mile west (the Rinaker-Benson well in sec. 27 and the diamond drill hole in sec. 23) indicate that the Herrin (No. 6) coal is 15 to 20 feet higher at these points than would be the case if the rise toward the west were uniform. It seems possible therefore that some deformation may have occurred in this vicinity and that a possible dome exists at the coal horizon slightly north and west of the shale exposure. The Rinaker-Benson well drilled $\frac{3}{4}$ mile south of the railroad bridge is said to have penetrated limestone at a depth of 385 feet below the surface and only 260 feet below the Herrin (No. 6) coal, and as reported it contained no sandstone. However, the Mutzbauer well drilled in the flood plain of Macoupin Creek by the Ohio Oil Company one mile northwest of the bridge, yielded a little gas with salt water in sandstone. This well was only 351 feet deep and the sand lies at the horizon of the upper bench of coal No. 2. The thinning of the Pottsville in the Rinaker-Benson well points to the presence of a high point or hill on the old pre-Pennsylvanian surface in this locality which remained as an island at least until the latter part of the Pottsville and which may have been covered at so late a date as to prevent the formation of the oil sands. The dome as shown is not decisively proved, and it is not certain that any of the oil-bearing sands are present beneath it.

SORENTO ANTICLINE

North and east of Sorento occurs a curiously warped structure which, nevertheless, appears to be well substantiated by exposures and drill records. The structure is a sharp east-west fold, open at the west. On the northeast side the datum plane drops off very sharply, being approximately 75 feet lower at Panama than on Shoal Creek in sec. 28, T. 7 N., R. 4 W., a distance of less than a mile. To the south the slope is less steep and to the north the difference in elevation is less than 30 feet. The structure as an anticline does not seem particularly favorable to the retention of oil since, in a continuous sand stratum, there would be nothing to prevent its escape to the west. Considered, however, in connection with the lenticular sand beds which characterize the oil-bearing horizon, it may furnish favorable conditions in lenticular sandstone bodies because of its steeper slopes and anticlinal character.

OTHER POSSIBLE AREAS

Many small and merely local deformations in the rocks have no doubt evaded detection, and when the slight deformation which was effective in producing the Carlinville oil pool and its small area are taken into consideration, it will readily be understood that there may be many apparently equally favorable localities which, through lack of rock exposures, it is not possible to point out.

East of Plainview in the northern part of sec. 10, T. 8 N., R. 8 W. the beds appear to be higher than elsewhere to the north, east, and west, the Herrin (No. 6) coal rising to 419 feet in the northwest quarter of this section. The evidence is lacking, however, to prove positively the existence of a dome. It is not improbable also that a slight upward warping exists west of the Mt. Pleasant church somewhere near the common corner of secs. 3 and 4, T. 8 N., R. 7 W., and secs. 33 and 34, in T. 9 N., R. 7 W., the contour lines swinging around this area suggestively.

At a point one and one-half miles southeast of Taylor Springs in the center of sec. 25, T. 8 N., R. 4 W., and also at a point one or one and one-half miles east of Hillsboro (both places, however, outside the area critically examined) the contour lines swing as though enclosing dome-shaped structures, but the positive proof is lacking. Just southeast of Gillespie, however, although the sweep of the 275-foot contour line strongly suggests a dome, the drill holes and mine workings demonstrate that the area is one of low, gentle, irregular warpings and has no well-defined dome structure, which shows that the curvature of the contour lines may be misleading.

LOCAL PRESENCE OF GAS

Since gas found in the drift in the Carlinville area was the cause of the discovery of oil and gas in the lower rocks it can scarcely be denied

that this phenomenon is to a certain extent an indication of oil, though it is more likely to be misleading than otherwise. It is interesting to note, therefore, though probably it is not of great importance, that gas has also been found in the glacial drift at Litchfield, this discovery following long after the exploitation of the oil. In September, 1913, a well on the farm of Eggie Rodenbeck in the NW. $\frac{1}{4}$ sec. 4 over a mile west of the oil wells, having gone dry was drilled 12 feet deeper. At 53 feet a pocket of gas-bearing quicksand was struck. Suspecting the nature of the gas a piece of lighted waste was thrown into the well, exploding the gas with such violence as to throw the windlass and planking some distance away from the top of the well.

O. L. Duncan shortly after sunk a well 200 feet distant on adjoining property and struck the gas at 52 feet. As this well caved, he put down another which struck the gas at 46 feet. The original pressure in the Rodenbeck well was reported to be 7 or 8 pounds, whereas that in the Duncan wells was only about half this amount. The gas was used in the houses of the owners of the wells, but in the fall of 1914 had almost ceased to flow. Gas was also reported to have been found in the drift near Hillsboro. A hole drilled to prospect the coal in the NW. $\frac{1}{4}$ sec. 35 is said to have given off gas in small quantities for several years. In 1909 a hole that was drilled nearby in the hope of striking oil reached a depth of 650 feet, but only a little gas was found. The hole drilled several years ago on the Telfers farm in sec. 22, T. 8 N., R. 5 W., by the Producers Oil Company continues to yield small bubbles of gas.

In none of these wells is the horizon from which the gas comes known. The presence of small quantities of gas, however, has little significance, and though oil is usually accompanied by gas, the reverse is commonly not true.

“KEROSENE” SPRING

In the SE. $\frac{1}{4}$ sec. 36, T. 9 N., R. 5 W. occurs a so-called “kerosene” spring which, since it has attained some local notoriety, it seems necessary to describe. The spring occurs in a small, steep-sided gully cut in the drift a short distance above its contact with “Coal Measures” shale. The choking of the gully 30 or 40 feet below the spring has caused the formation of a putrefying and stagnant mass of sticks, dead leaves, and clay. The accumulation is three feet or more deep and under normal circumstances the mouth of the spring is choked and the free flow of the water is prevented. It is quite saturated with oil that has a specific gravity of 45° B. and practically no residue, and therefore corresponds closely to commercial kerosene. It appears as an iridescent film on the water and is distinctly more conspicuous when the mushy mass is disturbed in any way.

In order to demonstrate whether the spring could be regarded as the source of the oil, the boggy material was dug out so that there was a free flow of water from the spring; an auger hole was bored horizontally into the spring at the point of greatest flow and a pipe was thrust 6 feet into the bank thus obtaining a source of water quite uncontaminated by the material about the mouth of the spring. The water flowing from the pipe was then caught in a bucket especially contrived to catch and retain any floating particles of oil. After three hours' test not the slightest oil film was found in the bucket and the water was found to be sweet and palatable. The water flowing from the spring was also observed to become free from iridescent skum. It is concluded, therefore, that whatever the source of the oil about the mouth of the spring it is not derived from the spring itself. The kerosene, which completely saturates the diminutive bog, is prevented from evaporating by an annual layer of freshly fallen dry leaves, and is prevented from escape by means of ordinary circulation by the practically impervious nature of the pulpy mass.

It is possible, therefore, that the oil may have been held in its present position for a number of years, for practically the only opportunity for escape is when the mass is trodden upon or disturbed by digging.

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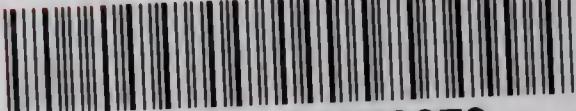
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